TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. XII, No. 3. MARCH, 1935. PRICE 6d.

CONTENTS.

	PAGE.
Minerals and Plant Health	53
Imperial Botanical Conference	55
Agricultural Labour in Trinidad	56
Rubber and Agriculture	64
The Lizards of Trinidad	65
Forestry in British Honduras	70
The Sand-fly Pest	71
Colouring of Citrus Fruit	73
Reviews	74
A New Hen	75
Chemical Composition of Grasses and Legumes	76
Chemical Notes	77
Notes on the biological Control of Insect Pests in the Bahamas	78
Sugar Notes	79
Trend of the Markets	80

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2183

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C.3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

MINERALS AND PLANT HEALTH.

ON reviewing the general trend of research in animal nutrition and soil science, a remarkable paralellism emerges. When scientific inquiry was first directed to the feeding of domestic animals, it was found that very significant weight increases could be obtained by careful rationing of the organic constituents, namely, carbohydrates, fats, and proteins. Similarly, the application to soils of farmyard manure or inorganic nitrogenous fertilizers was found to cause marked increases in the yield of crops. The important mineral elements, calcium and phosphorus, then proved to be indispensable to the health of animals, particularly those which were growing rapidly or giving high yields of milk or eggs. These two elements were also found to be indispensable to the plant and its soil. During the past 30 years, such researches have been remarkably successful, and cooperation with animal and plant breeders has resulted in higher yields and better quality in large areas of the agricultural world. Specific diseases of animals due to deficiency of phosphorus or calcium were controlled by adding these minerals to the food, and pastures were examined for their mineral content from the same point of view. Iodine was the next element to receive attention in animals, and its importance as a constituent of the secretion of the thyroid gland led to exhaustive researches which explained many puzzling pathological symptoms. At the same time, plant physiologists were formulating a theory that potassium is essential for photosynthesis, and the chemical investigations of haemoglobin and chlorophyll had focussed attention on iron and magnesium. The problems became more complicated, for it was found that some iron compounds would cure anaemia, but magnesium deficiency in itself would not account for chlorosis of plants.

The brilliant research work on the vitamins later overshadowed the mineral aspects of nutrition, and attention was again directed to the organic constituents of food. Meanwhile bacteriologists and mycologists were finding that, in some cases, increased resistance to disease occurred when the animal or plant was healthy and vigorous, and that bacterial or fungal attack was occasionally a secondary effect due to malnutrition. It was then realised that two types of diseases could be distinguished, one caused by the deficiency or lack of assimilation of certain elements, such as calcium, phosphorus, iodine, or potassium, and another type where the disease

is secondary, due to the lowered resistance of an animal or plant which can resist attack by the causal organism when it is in good health. The distinction between these two types is not always diagnostically clear, but the idea served to clarify the problem considerably. A wide field of research was thus thrown open, and greater interest was taken in plant diseases, either because of their increase through intensive methods of cultivation, or because mycologists had widened their knowledge of the symptoms and causes.

Many plant diseases have already been investigated by soil chemists and plant physiologists from this point of view, and in several cases it was found that cures could be effected by application of small quantities of minor elements such as manganese, iron, magnesium, boron, sulphur, copper or zinc. These elements occur in plants in extremely small quantities, and, until recently, it was believed that their presence was purely accidental and therefore of secondary importance. Not only can the absolute deficiency of one or more of them exert detrimental effects, but the excess of one over the others may result in what Lundegardh has called "a disturbance of the ionic balance". This "luxury consumption" of a particular element is probably not serious in animals, since the unassimilated portion may be voided in the excreta, but excessive ingestion in plants may disturb the equilibrium of the cell sap components, and cause a relative deficiency of other elements.

The part played by the minor elements in this important branch of agriculture is summarised in a recent publication by the Imperial Bureau of Soil Science*, and the literature cited is both extensive and informative. One striking feature is that many plant diseases can be prevented or cured by heavy applications of organic manure. It is well known that all plants conserve their supply of inorganic nutrients by returning them to the soil in the decaying vegetative tissue, and any agricultural process which breaks this sequence will tend to deplete the soil of these essential substances. It is not surprising, therefore, to find that annual crops which have their vegetative tissue harvested and removed are most liable to deficiency diseases. In temperate climates, oats have supplied numerous instances of this, particularly in Australia where it is seldom possible to return the straw to the fields. Manganese, magnesium, and copper have each proved to be limiting factors in this respect, and much of the original work on the function of these elements was carried out in that country. Many farms in England have been leased with the *proviso* that all the straw must be returned to the fields in the form of farmyard manure, and this long-established practice may have done much to prevent the occurrence of diseases of this kind.

In the humid tropics, atmospheric conditions are very favourable to the growth of parasitic organisms, and therefore the crops are normally subjected to intensive attack by disease. Thus, any lowering of resistance, due either to exploitation or overcultivation of the soil, will result in a rapid spread of disease and consequent crop failure. The exact relationship between soil deficiencies and resistance to disease is not known, but there is a growing tendency to apply solutions of these minor elements to diseased plants, either by injection or by spraying the leaves. The evidence available is not conclusive and much further work is necessary. On the other hand, many diseases which originally seemed to be micro-organic, and therefore likely to spread, have been proved to be directly or indirectly related to soil deficiency, and remarkable cures have been carried out by applying the appropriate chemical substance. Direct application is not always successful, and the "availability" of the element is the main consideration. For instance, it was found in South Australia that a disease of barley, similar to "grey speck" of oats, could be cured by drilling in manganese sulphate with the seed, although analysis of the soil gave a total manganese content which appeared sufficient for the requirements of the plant, had it all been in an available form. On the other hand, Wallace and Mann reported that chlorosis of fruit trees growing over a limestone formation in England could be checked only temporarily by direct application of ferrous sulphate. They obtained striking cures by planting cover crops over the roots of affected trees, thus increasing the concentration of carbon dioxide in the soil atmosphere and therefore encouraging the formation of ferrous compounds.

Of the tropical crops, tobacco is one of the most sensitive to deficiency of the less common elements in the soil. "Sand-drown" occurs in sandy soils in several parts of the United States and in Nyasaland, particularly on deep soils which have become waterlogged, heavy rainfall being an important factor. Applications of magnesium salts have cured the disease, which is considered to be due to magnesium deficiency in the soil, induced by leaching out of soluble magnesium compounds. "Top rot" of tobacco has been ascribed to deficiency of boron, and the disease has been cured by applying compounds of this element, but it is doubtful if boron deficiency is the sole cause of the disease.

Boron compounds are also important in citrus cultivation, although comparatively small quantities are liable to have toxic effects. Kelley and Brown found that a water-soluble boron content of the soil of more than 3 parts per million had a toxic effect in citrus plants. This subject requires much careful investigation, since luxury consumption is as dangerous as deficiency. Exantherma of citrus, also known as "die-back", has been reported from nearly every country where citrus is grown, and has been correlated with certain forms of organic matter in the soil. Several workers state that the incidence of exantherma is favoured by large quantities of organic manures and by poor drainage conditions,

* Technical Communication No. 31. "Soil Deficiencies and Plant Diseases."

but in a few cases it has been cured by copper salts, either by their action in neutralising soil toxins, or by their effect on the metabolism of the plant. "Rosette" of fruit trees has been cured by applying zinc sulphate, and this disease is also known in citrus.

A chlorosis of sugar-cane called "Pahala blight" occurred in Hawaii, and was first investigated by Lee and McHargue. They attributed it to manganese deficiency, but McGeorge eliminated the disease by manuring with sulphur. On the whole, the evidence indicates that iron is probably the most important element involved, and that the high alkalinity of the affected soils prevented the assimilation of this element. The effect of sulphur was to increase the uptake of iron but not of manganese. Further, Kelly found sugar-cane to be less sensitive to manganese than most cultivated crops. If grown in solutions free from boron, sugar-cane shows depressed growth, with distorted and chloritic leaves, the symptoms being similar to that of "pokkah 'bong" disease, due to *Fusarium moniliforme*. It has been suggested that the severity of this disease may be related to boron deficiency in the soil. Maize appears to be sensitive to lack of manganese or magnesium, although deficiency diseases have been comparatively rarely observed in the field, considering the very extensive cultivation of this crop. Soy beans have been known to respond to treatment with manganese, while both cotton and soy beans are recorded as being susceptible to chlorosis due to manganese deficiency. The availability of iron compounds seems to be an important factor in rice cultivation, and investigations by Gile and Carrero showed that rice is not particularly sensitive to the reaction of nutrient solutions provided that sufficient iron is available. Common rice is affected much less than mountain rice, since submergence of the soils tends to render the iron more available by reducing it to the ferrous state. Sulphur deficiency of rice was reported from the Mandalay Agricultural College, the plants turning yellow and remaining stunted. Only salts containing the sulphate radicle were successful in reviving the plants, sulphuric acid being as effective as metal sulphates. It was suggested that absolute deficiency of sulphur in the soil was responsible.

"Tea Yellows" in Nyasaland presented rather a curious problem. Storey and Leach carried out careful manurial experiments and found sulphur-containing manures to be the only effective treatment. They also produced the disease in sulphur-free water cultures. Yet the soils contained as much sulphur as is normally encountered in soils, and evidence of a higher sulphur content of healthy leaves was not conclusive.

The black colour of certain soils in Hawaii was considered at first to be a sign of inherent fertility, but the widespread occurrence of a disease called "pineapple yellows" stimulated scientific enquiry. It was soon found that the black colour is not due to organic matter but to a high content of manganese, which has a powerful retarding effect on the assimilation of iron by the plant. McGeorge was not satisfied with this explanation, and he concluded that the chlorotic symptoms were due to luxury consumption of lime, owing to the presence of large quantities of manganese in the soil. The consequent accumulation of lime in the leaves and stalk would prevent the free translocation of iron in the plant, and result in typical chlorosis. Control of the disease was effected by spraying the leaves with ferrous sulphate.

Even this brief resumé is sufficient to show that the minor elements in soil—manganese, iron, magnesium, boron, sulphur, copper and zinc—may be much more important in tropical agriculture than has been generally realised. The fact that deficiencies of these elements occur in temperate soils indicates the possibility of their frequent occurrence in tropical soils which are subjected to high rainfall or excessive oxidation. Many agricultural areas in the tropics were originally forest soils with high moisture content throughout the year, and therefore the oxidative processes must have been greatly increased on clearing the land. The apparently high iron content of most red soils may be misleading, in that a little iron goes a long way in colouring a soil, and the bright red colour suggests that an insoluble ferric oxide is the principal iron compound present. It is conceivable that the addition of small quantities of these minor elements to inorganic manures will become a regular practice, but the extensive use of organic manures may be the most effective remedy of all.

IMPERIAL BOTANICAL CONFERENCE.

An Imperial Botanical Conference, commencing on 28th August and lasting two to three days, according to the programme which may finally be arranged, will be held in London this year. The subjects set down for discussion are of general interest to Empire botanists, and include such topics as pasture research within the Empire, the ecology of tropical forests, the application of ecological methods to the study of native agriculture, problems of fruit storage and transport with special reference to tropical conditions, the furtherance of schemes for the closer co-ordination of botanical research within the Empire, &c. It is hoped that this Conference will furnish a convenient meeting ground for home and overseas botanists who are on their way to attend the International Botanical Congress which meets at Amsterdam in the week following. The chairman of the Organising Committee of the Conference is Sir Arthur Hill, director of the Royal Botanic Gardens, Kew, and the honorary secretary is Prof. W. Brown, Imperial College of Science and Technology, South Kensington, London, S.W.7, from whom further particulars may be obtained.—(*Nature*, Vol. CXXXV, No. 3401, 1935, p. 29.)

AGRICULTURAL LABOUR IN TRINIDAD.*

BY

C. Y. SHEPHARD.

I. THE IMPORTANCE AND DISTRIBUTION OF AGRICULTURE.†

[NOTE.—For convenience the term 'West Indian' is used to distinguish those not of East Indian parentage. Terms, such as Spanish, negroids and aboriginal Indians, are used to denote particular types of West Indians.]

Agriculture directly employs more than one-quarter of the total population of Trinidad, or, if children and those engaged in domestic occupations are excluded, nearly three-fifths of the adult population. A large proportion of the remainder is engaged in occupations indirectly dependent upon agriculture. There is a tendency for the numbers engaged in agriculture to decrease.‡ Nevertheless, the welfare of agriculture remains of vital importance to the Colony.

Cacao and sugar are the principal agricultural products. The total area of Trinidad and Tobago is 1,264,891 acres, of which 689,762 acres have been alienated. Cacao now occupies 209,000 acres; by far the largest area under any single crop. The areas under sugar and coconuts were recorded in 1926 at 32,874 and 36,940 acres, respectively; and in 1932 at 60,000 and 52,500 respectively.

Cacao also ranks first, amongst agricultural products, in export value. Approximately 55 million lb. of cacao, valued at nearly one and a quarter million pounds sterling, are annually exported, constituting nearly 28 per cent. of the total value of exports. Sugar products consisting of sugar, molasses, rum and bitters, however, form a close rival, exports averaging £1,200,000 in value, or a little more than 27 per cent. of the total domestic exports.* Other agricultural products are of very minor importance; coconuts, next in value, contributing less than 5 per cent. of the total exports. Coffee is of interest as a minor agricultural product. In 1922 only 329 lb. of coffee was exported but by 1925 this quantity

* Continued from February issue. pp. 43-47.

† *See* Diagram 1 on p. 58.

‡ In 1931 one-fifth of the total population was engaged in Agriculture.

* The situation has since changed. During 1931-33 cacao exports were valued at only £650,000 per annum, and sugar products at £950,000.

Table 6.—Division of the Population according to Occupations in 1911, 1921 and 1931 (6), (7), (16).

Occupations.	1911		1921		1931	
	No.	Percentage of whole.	No.	Percentage of whole.	No.	Percentage of whole.
Official and Professional	5,551	1.66	5,789	1.58	8,133	1.98
Commercial	7,039	2.11	14,411	3.96	15,305	3.71
Domestic	50,174	15.04	80,471	22.00	88,794	21.51
Industrial	55,328	16.59	40,007	10.95	49,945	12.10
Agricultural	97,121	29.12	95,577	26.12	89,505	21.69
Children	112,385	33.69	123,765	33.82	140,046	33.91
General and Indefinite	5,954	1.79	5,893	1.58	21,055	5.10
Total	333,552	100.00	365,913	100.00	412,783	100.00

Table 7.—Acreage under Principal Agricultural Crops (2), (3), (4), (17), (18).

Crop.	1920	1923	1926	1929	1932
Cacao	200,252	202,103	187,716	209,000	225,000
Sugar	43,265	34,719	32,874	44,000	60,000
Coconuts	36,531	41,113	36,940	50,000	52,500
Mixed Cultivation	16,829	11,568	35,951	12,210*a*	13,935 (*a*)
Others	15,893	18,183	18,676	—	—
Total	312,770	307,686	314,157	315,210	351,435

(*a*) Comprises acreages only in coffee, rice, rubber, limes and grapefruit.

had increased to over half a million lb. valued at over £28,000.* Other areas are rapidly coming into bearing, but the industry is not likely to prove a serious rival to either cacao or sugar. Small areas have recently been planted in grapefruit, and there is a small production of limes. A remarkable feature of the Colony's export trade has been the rapid development of the oil and asphalt industries which, in 1927, accounted for nearly 50 per cent. of the total value of domestic exports, and for the past five years averaged nearly 40 per cent.† The remaining articles of export amounted to only 1.38 per cent. of the total, and are relatively negligible. Cacao and sugar, therefore, predominate among agricultural exports.

The cacao industry is widely distributed throughout the island. The principal areas are located around the Western end of the Central Range, particularly in the ward of Montserrat, along the Western end of the Northern Range, to the South of Sangre Grande, and along the Southern Range. The greatest areas are located in the counties of St. Andrew and Caroni which have over 40,000 and over 35,000 acres, respectively, under this crop. St. George, Victoria and St. Patrick, also, each have between 20,000 and 30,000 acres under cacao, while in St. David, Nariva and Mayaro the areas are relatively small.

* The quantity of coffee exported in 1929, amounted to 817,983 lb. valued at £32,309 and in 1932 to 908,492 lb. valued at £20,822. In 1933 exports fell to 339,196 lb. valued at £7,416.

† For the period 1922-1933, the value of the oil and asphalt exports averaged nearly 48 per cent., cacao 24 per cent. and sugar 22 per cent.

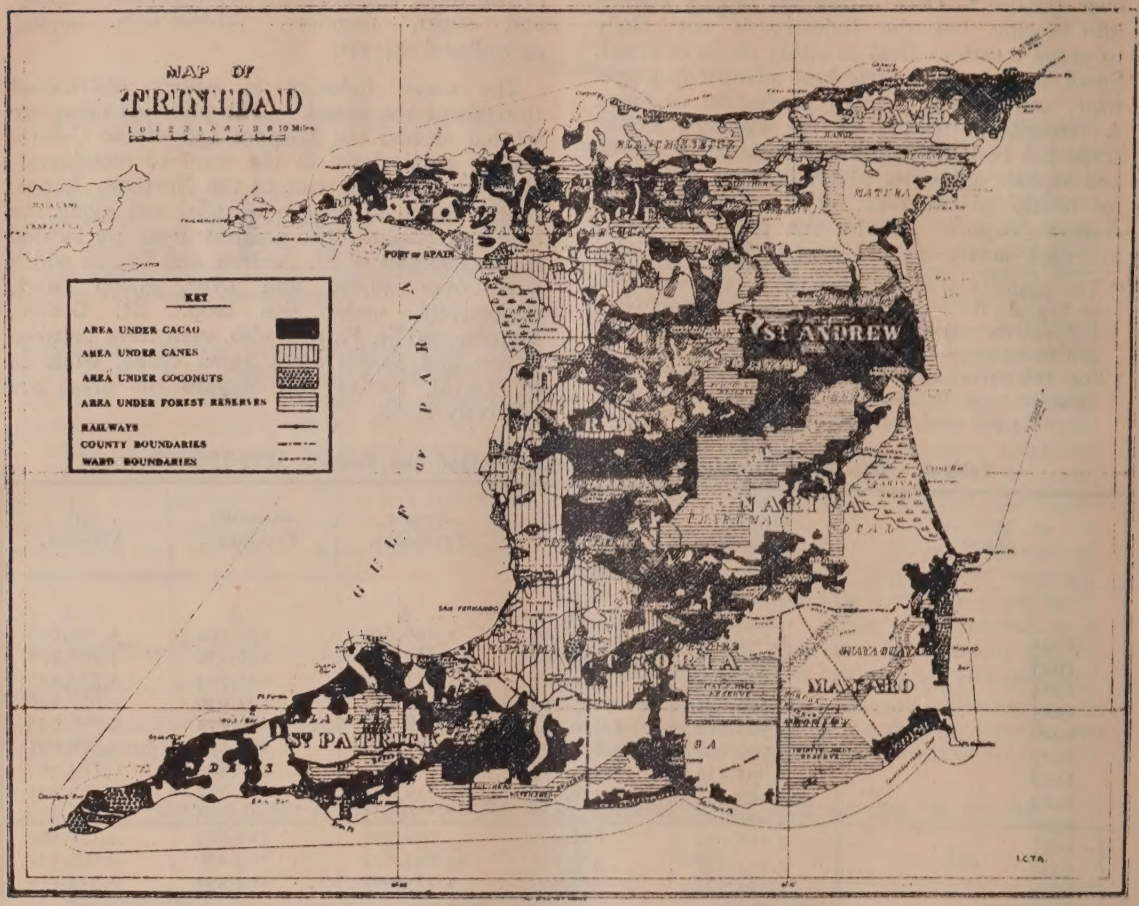
Table 8.—Exports of Domestic Produce from Trinidad and Tobago, 1922-1933 (8).

Year.	Oil and Asphalt.	Cacao.	Sugar Products.	Coconut Products.	All Articles.
	£	£	£	£	£
1922	1,104,670	1,196,166	1,196,650	178,991	3,706,618
1923	1,616,274	1,286,494	1,167,725	196,150	4,298,378
1924	1,756,045	1,165,816	1,321,417	222,764	4,521,225
1925	1,920,641	1,257,255	1,203,193	192,830	4,677,148
1926	2,323,818	1,270,335	1,118,408	206,771	5,006,955
1927	2,700,836	1,671,883	762,366	179,193	5,588,091
1928	2,895,854	1,651,179	1,201,477	262,379	6,184,464
1929	3,483,535	1,446,127	1,049,863	276,052	6,539,343
1930	3,104,471	1,136,056	776,167	201,795	5,372,423
1931	2,186,052	826,333	902,990	113,697	4,170,594
1932	2,514,497	579,170	845,874	104,266	4,195,432
1933	2,404,922	555,907	1,115,567	104,351	4,324,114
Total	28,011,614	14,042,721	12,661,697	2,239,239	58,584,785
Annual average	2,334,301	1,171,060	1,055,141	186,603	4,882,065
Average annual percentage	47.82	23.99	21.62	3.81	100
Average annual percentage 1924-26	39.27	27.81	27.05	4.49	100

Table 9.—Exports of the Principal Articles of Domestic Produce. Quantities, 1922-33 (8).

Year.	Oil.	Asphalt.	Cacao.	Sugar.	Molasses.	Rum.	Coconuts.	Copra.
	1,000's Galls.	1,000's Tons.	1,000's Lb.	1,000's Lb.	1,000's Galls.	1,000's Galls.	1,000's No.	1,000's Lb.
1922	56,360	139	50,646	116,148	198	23	18,646	9,429
1923	85,136	172	67,692	79,572	128	24	12,228	13,159
1924	112,859	169	56,403	97,265	1,506	83	9,928	11,180
1925	126,231	158	49,477	135,860	1,271	28	8,634	9,965
1926	139,581	181	50,068	147,121	1,427	71	5,041	13,859
1927	155,987	186	51,935	93,644	1,189	36	6,464	12,499
1928	222,659	152	58,008	166,011	1,622	55	6,800	21,352
1929	288,506	164	61,889	182,568	1,373	74	13,608	23,980
1930	268,771	118	53,825	154,871	899	72	5,886	21,891
1931	313,750	93	57,187	192,761	1,599	86	4,488	19,485
1932	337,312	51	41,822	192,543	2,702	140	3,847	15,419
1933	311,825	52	51,311	343,077	3,026	64	7,889	19,358

Fig I.—Map of Trinidad showing the distribution of the major crops, namely Cacao, Sugar and Coconuts.



NOTE.— *Information recently made available indicates several small deviations in the present distribution of the major crops. These differences are not of sufficient importance to warrant the preparation and printing of a new map.*

At one time sugar estates were scattered along the Western, and parts of the Southern and Eastern coasts, in locations affording fairly easy shipment to Port-of-Spain. After the abolition of slavery, the few isolated estates at Toco and Mayaro succumbed. With the centralisation of sugar manufacture towards the end of the nineteenth century, the small sugar estates in Cedros were gradually abandoned, or replanted in coconuts or cacao. To-day the sugar industry is definitely concentrated in the drier and sunnier Western part of the island, in the areas of relatively low relief, particularly in the counties of Caroni, Victoria and to a smaller extent, St. George. Sugar cultivation is unimportant in the Eastern and South-Western counties.

The coconut industry is widely distributed around the coast where proximity to the sea affords good natural drainage. The principal concentrations are around the South-Western peninsula, along the Eastern coast, and around the North-Western peninsula. The counties of St. Patrick, Nariva and Mayaro, and St. George possess the largest areas under this crop.

The Western counties of Caroni, St. George and Victoria, are the most highly developed agriculturally, probably on account of the relatively easy access to the safe anchorage provided by the Gulf of Paria. The extension of the railway, and the development of motor transport, have diminished the advantages of the Western counties, and considerable development, for example, has, within recent years, taken place in the cacao industry in St. Andrew, focussed upon the town of Sangre Grande. Considerable areas of hilly land, mostly with poor soil, have been reserved in the Eastern counties as forests for the conservation of rainfall and the provision of charcoal.* There is a large swamp in Nariva only portions of which are available for rice cultivation.

The Western counties contain over half the total cultivated area, the Eastern counties little more than one-third, and the South-Western county less than one-seventh.

* The total area so reserved amounts to 229,760 acres (5).

Table 10.—Acreage under the Principal Agricultural Crops in the various Counties of Trinidad 1926 (5).

County.	Cacao (acres)	Sugar (acres)	Coco-nuts (acres)	Other Crops (acres)	Total (acres.)
Western :					
St. George ..	27,052	5,176	5,197	6,153	43,578
Caroni ..	35,671	20,025	2,341	4,289	62,326
Victoria ..	25,122	4,893	1,111	2,292	33,418
Eastern :					
St. David ..	9,907	4	1,735	341	11,987
St. Andrew	40,637	89	3,512	2,188	46,426
Nariva and Mayaro	15,220	307	6,378	151	22,056
South-Western :					
St. Patrick ..	23,106	380	7,666	5,090	36,242
Total ..	176,715	30,874	27,940	20,504	256,033

II. Racial Distribution of Agriculturists.*

The population is similarly concentrated in the Western part of the island. The three Western counties comprise less than half of the total area but contain more than three-quarters of the total population. The Eastern counties, which aggregate nearly two-fifths of the total area, possess less than an eighth of the total population. St. Patrick with less than one-seventh of the total area contains one-tenth of the total population.

The distribution of agriculturists is similar, except that St. George, the most densely populated county, falls into third place among agricultural populations. The Western counties contain nearly three-quarters, the Eastern counties less than one-seventh, and St. Patrick a little more than one-tenth, of the agricultural population.

* *See* Diagrams 2 and 3 on pp. 60 and 61.

Generally, then, both the agricultural areas and the agricultural population are concentrated in the Western Counties. The markedly greater density of the agricultural population in the Western Counties is not wholly accounted for by the amount of land under cultivation. The crops cultivated differ greatly in their labour requirements; thus, while one labourer suffices for six or seven acres of cacao, one is needed for each acre under sugar-cane. The localisation of the sugar industry in the Western counties is therefore partly responsible for their greater density of agricultural population.

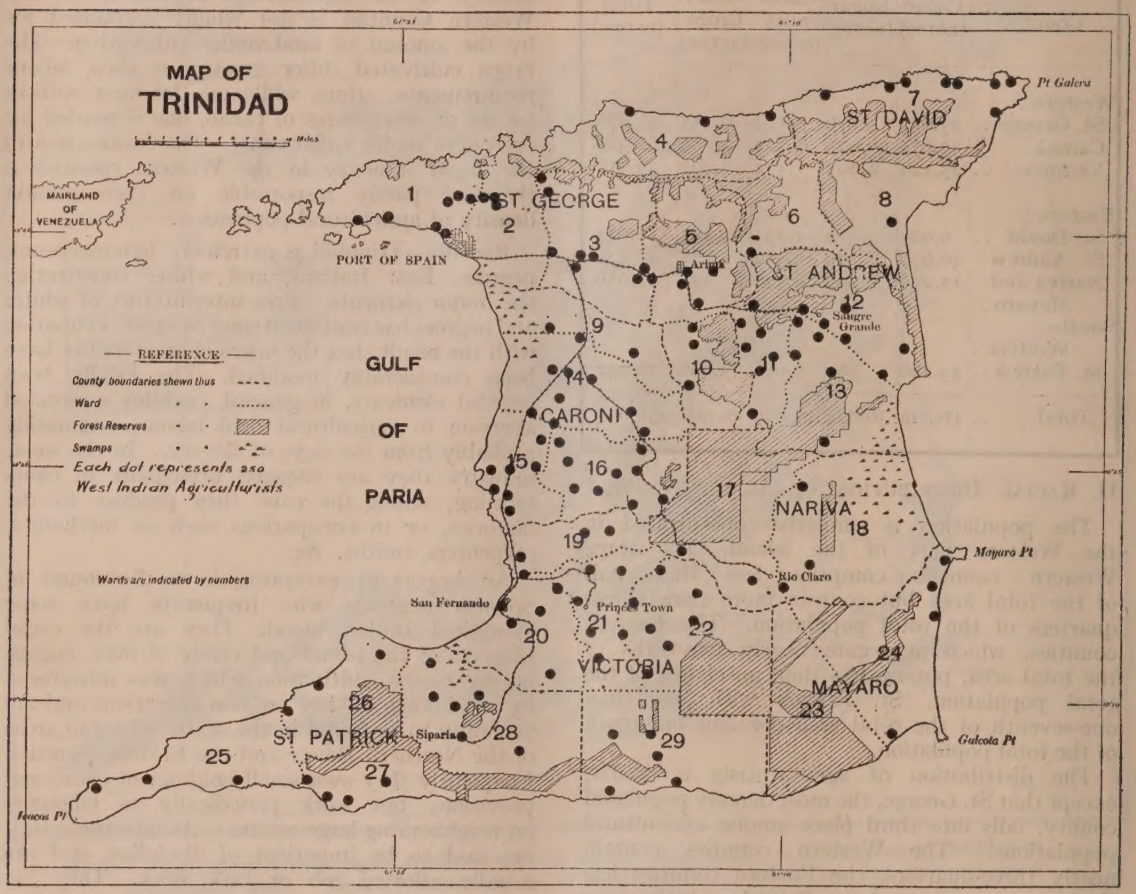
Racially, Trinidad is extremely heterogeneous, negroes, East Indians, and whites constituting the major elements. Free intermixture of whites and negroes has continued since Spanish occupation with the result that the negro characteristics have been considerably modified. The locally born negroid elements, in general, exhibit a decided aversion to agricultural field labour, originating probably from the days of slavery. In the sugar industry they are engaged principally in cane-farming, selling the cane they produce to the factories, or in occupations such as mechanics, carpenters, smiths, &c.

An important exception is to be found in Spanish negroids who frequently have some aboriginal Indian blood. They are the cacao pioneers of the island and rarely, if ever, engage in sugar-cane cultivation which was introduced by the French. They are non-gregarious and are generally to be found in the scattered cacao areas of the Northern Range and the Eastern counties. Frequently they own small holdings of cacao and provisions, but work periodically as labourers on neighbouring large estates. As labourers, they are said to be impatient of discipline, and are usually allotted job or task work. They are highly skilled in tree work, such as pruning and picking, but dislike working with the hoe. Their skill and industry enable them to earn high wages.

Table 11.—Distribution and Density of the Total and Agricultural Populations for 1921 and 1931 by Counties (7), (16).

Counties.	Total Population (1921).			Agriculturists.		Total Population (1931).			Agriculturists.	
	Population.	Area in sq. miles.	Density per sq. mile.	Population.	Density per sq. mile.	Population.	Area in sq. miles.	Density per sq. mile.	Population.	Density per sq. mile.
Western :										
St. George	133,325	317	421	16,082	51	161,327	358	451	17,428	39
Caroni	53,961	253	213	23,020	91	51,193	214	239	19,125	80
Victoria	77,679	315	248	27,396	88	74,439	315	236	22,283	94
Eastern :										
St. David	6,679	79	85	2,144	27	5,664	79	72	1,787	25
St. Andrew....	23,576	287	82	7,767	27	23,237	283	82	7,959	25
Nariva	8,487	200	42	2,871	14	10,809	206	52	3,741	18
Mayaro	3,846	151	25	1,217	8	4,037	146	28	1,381	9
South-Western : St. Patrick....	34,075	261	130	9,538	37	46,531	261	178	10,037	38

FIGURE 2. Shewing distribution of West Indian Agriculturists



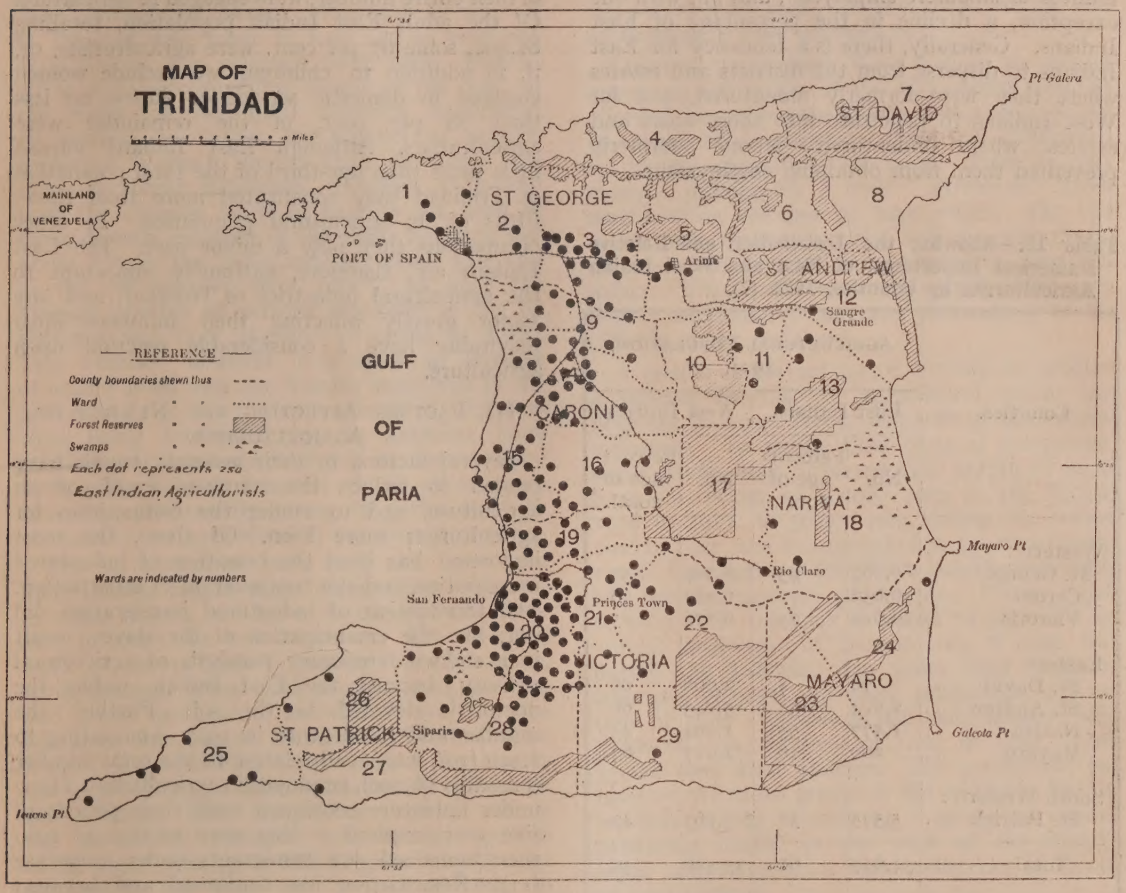
The locally born negroid population has been supplemented by immigrants, chiefly male, from the smaller and more thickly populated West Indian islands. Prior to the slump of 1921, it was customary to bring labourers from Carriacou, Barbados, and other islands, for the sugar-cane reaping season. Many others came, occasionally with the assistance of the estates, from St. Vincent and Grenada, to work on the cacao estates. In 1921(7) Trinidad and Tobago contained 47,044 persons born in other West Indian islands of whom 16,744 came from Barbados, 12,888 from Grenada, and 10,113 from St. Vincent. Although the number of these immigrants engaged in agriculture is unknown, many are to be encountered on estates, particularly in the cacao areas.

With the exception of the Spanish negroids, a relatively small percentage of the locally born negroids is engaged in agriculture. Although of fine physique they are regarded as irregular, unreliable, irresponsible, and impatient of discipline. They are fond of urban life and generally gravitate towards the larger villages and towns. They are managed best through their elementary but ready sense of humour. The type which remained devoted and loyal to the estate and its family traditions is considered rapidly to be disappearing.

The Chinese and Portuguese elements, descendants of the labourers introduced after the abolition of slavery, supplemented by more recent immigration, are engaged principally in the retail trade and are seldom to be found as estate labourers. The characteristics of the aboriginal Indians have been merged, by miscegenation, with those of other races, though they dominate, in a few cases, in the less accessible parts of the Northern Range.

The distribution of West Indian agriculturists is relatively even. In the sugar-cane area they are greatly outnumbered by East Indians. They constitute practically the entire agricultural population of the Northern Range cacao and coconut areas, and outnumber the East Indians in the cacao area around Sangre Grande, the coconut belt of Mayaro, and the cacao area of Moruga. Although West Indians number 220,553, or nearly two-thirds of the total population of Trinidad (excluding Tobago), only 35,420, or less than one-sixth, are agriculturists.(7)

FIGURE 3. Shewing distribution of East Indian Agriculturists



East Indians, including all of East Indian parentage, are derived from many castes possessing widely different characteristics. The majority however, were low caste Hindus whose traditional occupations were connected with agriculture. In general they are of poorer physique than the West Indians but are more regular and reliable workers and more amenable to estate discipline. Caste distinctions are disappearing, but religion, dress, and mode of living, are largely retained. There is a tendency for the creole born East Indians, particularly the Mohammedans, to adopt European dress and habits. Although they are beginning to enter commercial and industrial occupations, they remain primarily agriculturists.

The great majority of the indentured East Indians were employed on the sugar estates, and only latterly were a few employed on cacao and coconut estates. They were never employed in the less accessible, and older established, cacao areas of the Northern Range because the supply of labour was already adequate and the isolation of the estates made compliance with the medical requirements of the Immigration Ordinance extremely difficult. East Indians and their descendants are concentrated in the sugar belt, particularly in the counties of Caroni and Victoria where in 1921, they comprised nearly three-quarters of the entire agricultural population. They slightly outnumbered the West Indians in the cacao districts of St. Patrick and Nariva, but were a little less in St. George. In the remaining counties, notably in St. David, the West Indians greatly predominated.

A striking characteristic of estates formerly employing indentured labourers is their continued dependence upon East Indians. In 1913-14, out of the aggregate of 25,094 labourers on estates employing indentured labourers, only 2,782, or 11 per cent., were West Indian.(9) Since the termination of indentured immigration, however, there has been a definite tendency, which is becoming increasingly marked, not only for East Indian agriculturists to diminish in total numbers, but also for them to disperse into areas in which, at present, they are numerically unimportant. By 1919 the percentage of East Indians on estates employing indentured immigrants had fallen to 85 per cent. Of 21 estates statistically examined

during 1928-29 all show a decline in the total number of labourers employed*, and all, with one exception, a decline in the percentage of East Indians. Generally, there is a tendency for East Indians to disperse from the districts and estates where they were formerly indentured, and for West Indians to penetrate into those areas and estates where indentured labour formerly prevented them from obtaining employment.

Table 12.—Showing the Distribution and Relative Numerical Importance of East and West Indian Agriculturists by Counties, 1921 (7).

Counties.	Agricultural Population, 1921.			
	East Indians.		West Indians.	
	No.	Percentage of total.	No.	Percentage of total.
Western :				
St. George ..	7,287	45	8,797	55
Caroni ..	16,658	72	6,362	28
Victoria ..	20,620	75	6,776	25
Eastern :				
St. David ..	76	4	2,068	96
St. Andrew ..	2,624	34	5,143	66
Nariva ..	1,577	55	1,294	45
Mayaro ..	200	16	1,017	84
South-Western :				
St. Patrick ..	5,575	58	3,963	42
Total ..	54,617	61	35,420	39

East Indians play a more important rôle in agriculture than their aggregate numbers would suggest. In 1921 they numbered 121,066, or 35 per cent. of the total population of Trinidad.

Table 13.—Showing the Relative Numerical Importance of East Indians engaged in certain occupations. Trinidad, 1921 (7).

Occupations.	Total No.	East Indians.	
		No.	Percentage of total.
(i) Official ..	1,590	70	4.40
(ii) Professional	4,013	117	2.92
(iii) Commercial ..	14,001	1,975	14.11
(iv) Industrial ..	37,515	11,071	29.51
Total (i)-(iv) ..	57,119	13,233	23.17
(v) Agriculture ..	90,040	54,617	60.65

*The first fortnight in June was selected for the purpose of ascertaining the numbers employed.

No less than 54,617 East Indians, or 45 per cent. of their entire number, were engaged in agriculture. Of the adult East Indian population, totalling 81,492, some 67 per cent. were agriculturists, or, if, in addition to children, we exclude women engaged in domestic service or duties, no less than 78 per cent. of the remainder were agriculturists. Although East Indians formed little more than one-third of the total population of Trinidad they constituted more than three-fifths of its agricultural population. In other occupations they play a minor part. The East Indians are, therefore, extremely important to the agricultural industries of Trinidad, and any factor greatly affecting their numbers must inevitably have a considerable reaction upon agriculture.

III. Factors Affecting the Number of Agriculturists.

Several factors, in their general trend, have tended to reduce the numbers employed in agriculture, and to render the competition for agriculturists more keen. Of these, the most important has been the cessation of indentured immigration and the continuation of repatriation. The termination of indentured immigration did not, like the emancipation of the slaves, result in a sudden temporary paralysis of agricultural activity, because the East Indian, unlike the negro, is devoted to the soil. Further, the number under indenture in 1917, amounting to 4,349 (10), was small relative to the total number (probably 96,000), employed in agriculture. Those under indenture continued until their periods of five years expired so that even as late as 1920 there remained 502 immigrants under indenture (11). Repatriation has continued and between 1920 and 1927 (12) some 11,061 East Indians left for India. Of the 4,671 that left during 1923 and 1924, some 2,164 were labourers and 1,450 were proprietors, canefarmers, or shopkeepers, so that a considerable proportion were directly engaged in agriculture. This process will continue as long as there remain in the island any entitled to assisted return passages. The loss to the agricultural industries of the island is serious.

Table 14.—East Indians repatriated since 1917 (12).

Year.	Total No.	Free Passage.	Assisted Passage.	Paid own Passage.	Dependents.	Rejected Paupers, Unfit, &c.
1920	893	91	293	17	128	—
1921	2,472	146	1,163	35	847	—
1922	1,075	76	612	13	196	—
1923	994	75	564	38	188	129
1924	886	60	482	15	111	218
1925	898	46	478	11	123	240
1926	996	34	434	33	110	385
1927	897	38	463	6	150	240
1929	938	39	395	3	106	395
1931	1,012	22	296	15	136	543

The rapid expansion of the oil industry is another factor to which many estates attribute their shortage of labour. Attempts to win oil in Trinidad were made as long ago as 1857 but little success was achieved until 1908. Mineral oil in 1927 accounted for nearly 42 per cent. of the value of the total domestic exports.(8) In relation to values, the number of persons employed is much smaller than in either the cacao or sugar industries. Between 1912 and 1926 the average value of exports per head of those directly engaged in the sugar industry was about £35, in the cacao industry about £40, and in the oil industry over £400*. In 1927 the average number of persons employed in the oil industry was only slightly in excess of 5,000. This number, however, represents an increase of nearly 4,000 over the number employed in the period 1913 to 1917 when indentured labourers were being introduced.(14) In addition, large numbers are at present employed in constructional work. The labour demands of the oil industry have expanded rapidly during the period in which the number of agriculturists has been decreasing.

The oil companies have had, and have been able, to offer higher wages than either the cacao or sugar estates and have, in consequence, been able to select the best labourers. The unskilled work of the oilfields is usually very laborious, while the semi-skilled work requires good physique and some mechanical knowledge, so that the labourers are almost exclusively West Indian. Except for unskilled constructional earthwork, the oilfields tap a different source of labour to the estates. This competition chiefly affects the mechanical transport and factory sections of the sugar industry in which regular employment throughout the year can be offered only to a limited number. Thus, one group of sugar estates employs 9,000 units of labour fortnightly in the factory during the crop season, which lasts approximately four months, and only 4,500 units during the remainder of the year.(13) The effect upon agriculture is less than a consideration of mere numbers employed would suggest.

The labour demands of the asphalt industry have been also increased, though the total number employed, now about 1,000, is small in relation to the output value, which averaged, during the five years 1923 to 1927, £408,000 per annum, or over £400 per labourer employed (8) (14). The pitch is laboriously dug by pickaxes so that only West Indians of the finest physique are employed. Both the oil and asphalt industries pay higher wages than the estates and provide more regular employment (13). The labour communities are small but concentrated and relatively urbanised, which, combined with the fact that the industry is not agricultural, provides conditions particularly attractive to the negroids. These labourers earn and spend more than agricultural labourers, and no shortage is ever experienced.

Children, particularly West Indian, are taking increasing advantage of the educational facilities afforded throughout the Colony. Having acquired an elementary education they are disinclined to become agricultural labourers. Prior to 1921 many immigrants were attracted from neighbouring colonies by high wages. The rise in wages in their own areas, and the agricultural depression in Trinidad, have tended to stem this influx. There has been a tendency for labourers, mostly negroids, to emigrate, particularly to the oilfields of the mainland.

A further important factor tending to produce a relative shortage of agricultural labour has been the increased labour demands of agricultural industries. To reduce their costs of production, sugar estates have increased their output of sugar from an average of 53,000 tons in the decade 1908 to 1917, to 56,000 tons during the period 1918 to 1927, and to a record of 81,551 tons during 1928. Cane-farmers have been largely responsible for this increase in production. During 1908 to 1917 their numbers averaged 14,595 with an annual production of 220,000 tons of cane, but during the following ten years their numbers averaged 20,985* and their production 302,000 tons of cane. Of the 20,668 cane farmers who produced 375,162 tons of cane in 1928, some 13,224 were East Indians. The production per head of the racial groups is not available but an analysis of the returns of a group of estates producing nearly 40 per cent. of the island's sugar crop, revealed a slight difference in favour of East Indians.

Table 15.—Annual average production of sugar, numbers of East and West Indian canefarmers and their production of cane for ten yearly periods from 1898-1927 and from 1928-1934 (1).

Period.	Tons of Sugar made.	Canefarmers.			Tons of Cane produced.
		East Indian.	West Indian.	Total.	
1898-1907 ..	53,174	4,350	4,668	9,018	156,421
1908-1917 ..	53,333	8,171	6,424	14,595	219,997
1918-1927 ..	55,239	12,320	8,665	20,985	302,239
1928-1934 ..	96,229	11,630	6,307	17,937	396,725

Cacao production has also tended to increase. The average annual exports for the period 1908 to 1917 were less than 54 million lb., and for the period 1918 to 1927 more than 58 million lb.

* Calculated by dividing the annual average value of exports for the period 1922-26, by the estimated number of individuals directly employed. Little importance should be attached to the absolute correctness of these figures which are intended merely for comparative purposes.

* The number of canefarmers was exaggerated, particularly during the slump of 1921, by the practice of sending canes to the factory in names other than that of the grower for the purpose of avoiding the repayment of advances.

Production has fallen to an average of 55 million lb. during the past five years (1923-1927) owing to declining yields and the conversion of unprofitable cacao estates near the sugar belt to sugar-cane. The demand for the labour for coconut estates has probably increased.

On the other hand the reservation of about two-thirds of the Crown Lands for oil prospecting has hindered the expansion of the peasant proprietary, and in this way tended to maintain the supply of estate labourers. In 1924 some 98,000 acres were temporarily withheld from sale and a further 124,833 acres licensed or leased for oil prospecting (15).

The general trend is for an increased demand for agricultural labourers, particularly by the sugar estates, and for general labourers by other industries, with a decline in the numbers of agricultural labourers, owing to the repatriation of East Indians, and to the growing disinclination of individuals to become agricultural labourers.

Summary.

I. The Importance and Distribution of Agriculture.

Nearly three-fifths of the adult population of Trinidad is engaged in agriculture, cacao and sugar being the staple crops.

The cacao industry is distributed over the whole island but the sugar industry is concentrated in the Western counties which support nearly three-quarters of the agricultural population.

II. Racial Distribution of Agriculturists.

West Indians are evenly scattered over the agricultural area, the Spanish negroids being identified with the cacao industry.

Although East Indians number little more than one-third of the total population they comprise more than three-fifths of the agricultural population, and are chiefly concentrated in the sugar belt.

III. Factors Affecting the Number of Agriculturists.

The continued repatriation of East Indians, and the increasing labour demands of the oil and other industries, tend to reduce the available number of agricultural labourers.

The trend towards an increased production of agricultural products, particularly sugar, involves an increased demand for agricultural labour.

The reservation of Crown Lands for oil prospecting has hindered peasant agriculture and helped to maintain the supply of estate labour.

Generally there is a trend towards a diminished supply of, and an increased demand for, labourers suitable for agricultural field work.

Literature Cited.*

1. Agricultural Society, Proceedings of, Trinidad, Vol. XXVIII. Part 7, p. 320. Vol. XXXV, Part 8.
2. Blue Book, 1920, Trinidad, 1921.
3. Blue Book, 1923, Trinidad, 1924.
4. Blue Book, 1926, Trinidad, 1927.
5. Blue Book, 1927, Trinidad, 1928.
6. Census Report, 1911, Trinidad, 1913.
7. Census Report, 1921, Trinidad, 1923.
8. Customs Reports, 1927, C.P. No. 68 of 1928—1933, C.P. 62 of 1934.
9. Immigration, 1913-14, C.P. No. 114 of 1914.
10. Immigration, 1917, C.P. No. 72 of 1918.
11. Immigration, 1920, C.P. No. 55 of 1921.
12. Immigration, 1920-27; C.P. Nos. 55 of 1921, 76 of 1922, 43 of 1923, 45 of 1924, 33 of 1925, 39 of 1926, 37 of 1927, 45 of 1928, 46 of 1930 and 43 of 1932.
13. Labour, Restriction of Hours of, C.P. No. 50 of 1926.
14. Mines Department, 1927, C.P. No. 66 of 1928.
15. Trinidad and Tobago, Handbook of, Government Printing Office, Trinidad, 1924, p. 107.
16. Census Report, 1931, Trinidad.
17. Blue Book, 1929, Trinidad, 1930.
18. Blue Book, 1932, Trinidad, 1933.

*All the literature cited, with the exception of (1), is published by the Government of Trinidad.

RUBBER AND AGRICULTURE.

The rapid development of the rubber industry has been one of the most notable industrial events of the present century. Between 1910 and 1933, the net amount of crude rubber exported from the principal producing countries increased from 94,000 tons to 851,000 tons per annum, while the world absorption of the manufactured product rose from 85,000 tons to 814,000 tons during the same period. Although the demand for motor tyres has been primarily responsible for this expansion, rubber has now found its place in practically every branch of industry. To illustrate the various ways in which it may be used on the farm, the Rubber Grower's Association (2-4, Idol Lane, Eastcheap, E.C.3) has issued a booklet entitled " Rubber and Agriculture ". In outdoor equipment, not only can tyres of every description be supplied to suit everything from a tractor to a wheelbarrow, but also jointed tracks are successfully made. The inconvenience of the ordinary tipping device for unloading lorries is now avoidable by using a vehicle fitted with a rubber movable floor, which discharges on either side as desired. In the cow-shed and dairy, rubber stalls and flooring, rubber parts to the milking machines and rubber rims to the churns to reduce noise, are some of the uses to which this product can be put. In the farmhouse itself rubber is becoming increasingly popular; rubber floor coverings, brushes and even rubber upholstery now being practical propositions, while for the farmer and his family, rubber clothing of various types is a recognised part of their outfit.—(*Nature*, Vol. CXXXV, No. 3401, 1935, p. 27.)

THE LIZARDS OF TRINIDAD.

By H. W. Parker, B.A.,
Department of Zoology, British Museum (Nat. Hist.).

The interdependence of cats and clover, first cited by Darwin, and its later, facetious extension, is almost too well known to bear repetition. The traditional food of Englishmen is roast beef; beef-production is intimately linked with clover-growing; clover is fertilised by humble bees; the nests of the latter are destroyed by mice; mice are kept down by cats which are often maintained by elderly spinsters; hence the food-supply of the manhood of Old England is largely governed by the number of maiden ladies keeping cats! A little far-fetched, perhaps, but ecological chains of this kind, with unexpected links here and there, often have the utmost importance for mankind. Unfortunately very little attention has hitherto been paid to lizards from this point of view and consequently we are still very ignorant of their economic importance. Very few are directly valuable to man, but, of the 19 species definitely known to occur in Trinidad, two have economic potentialities of this nature. First there is the "Guana" (*Iguana iguana*) whose flesh is not only edible, but much esteemed in many parts of South America, and whose skin is widely used in the leather trade; a few years ago several million skins a year were being exported from Brazil and although the demand has slacked off somewhat recently there is every likelihood that the skins will continue to have some economic value. The Teju (*Tupinambis nigropunctatus*) comes into the same category as the Iguana, its skin being widely used for fancy leather and having a somewhat greater value; unfortunately the flesh is not palatable, and, during recent years the animal has become increasingly scarce in Trinidad.

But the indirect importance of the remaining species is probably much greater than the slight direct economic value of the preceding. All, so far as is known, feed almost exclusively on invertebrates, particularly insects, and consequently it is highly probable that the control they exercise over the numbers of these creatures, more especially of those injurious to agriculture, is of no little importance. Very little work has been done on the feeding habits and food preferences of Trinidad lizards but the following lists of stomach contents and notes made recently by Mr. D. Vesey FitzGerald, will serve to show the nature of the food:

(1) *Thecadactylus rapicaudus.* The Wood Slave has been seen to feed on many large nocturnal insects such as cockroaches, long-horned grasshoppers, &c.

(2) *Anolis chrysolepis.* Two specimens examined contained a caterpillar, grasshopper, wood-louse and a dipterous larva.

(3) *Plica plica.* This lizard seems to prefer dark coloured, much chitinised insects, and tolerates stings and smells (Pentatomids). Four specimens were found to have eaten:—Many ants, several bees, numerous beetles, a large Carabid larva, a Mutillid and a Pentatomid plant bug.

(4) *Cnemidophorus lemniscatus lemniscatus.* Two specimens contained:—Five caterpillars, several grasshopper nymphs, one adult Tettigonid grasshopper, an ichneumon fly and a Reduviid bug.

(5) *Scolecosaurus trinitatis.* One stomach contained a small earwig, a dipterous larva and a mass of Mycetophilid larvae.

It is evident that the nature of a lizard's food must be largely conditioned by its size and the relative abundance of the different kinds of potential prey in the animal's natural haunts during its periods of activity. Although they are usually catholic in their tastes, there is a good deal of evidence that lizards exercise some discrimination and do not merely accept anything which comes within their range. But much work remains to be done before it is possible to assess their economic importance, and since the different habits and habitat preferences of the various species have a material influence upon the nature of the food which is accessible to them, an essential preliminary to any such work is a ready means of identifying the individual species. The following notes will, it is hoped, fulfil this purpose.

No complete list of the lizards of Trinidad has appeared since 1894 when Mole and Urich published "A Preliminary List of the Reptiles and Batrachians of the Island of Trinidad" in the *Journal of the Trinidad Field Naturalists Club*, Vol. II, pp. 77-90. In that paper 24 species of lizards are listed and although only a single additional species has been discovered on the island during the succeeding 40 years, the status and names of so many of the others have been changed as a result of research during the period, that a revised list appears necessary. In a previous number of *Tropical Agriculture** the author gave a list of the frogs and toads of the island, together with a key intended to facilitate their identification; a similar key to the lizards is now offered, together with systematic notes on the various species. In this systematic list a series of references is given under each specific or sub-specific title; the first references are to the original descriptions of the species, from which the names date; then follow the first record from Trinidad (if different from the first description) and any other Trinidad references which may have appeared under different names; lastly, where possible, an additional reference is given indicating where a good figure of the animal is to be found. The number of such figures is, unfortunately, very small but technical descriptions of all species described prior to 1887 are to be found in the Catalogue of Lizards in the British Museum (Boulenger 1885-1887).

* Vol. X, No. 1, 1933.

A. SPECIES PROBABLY INCORRECTLY REPORTED FROM TRINIDAD.

(1) Anolis biporcatus (Wiegmann).

This species was recorded from Trinidad by Boulenger (1885, II, p. 88) on the basis of a specimen received by the British Museum in 1863 from a Mr. C. Taylor. Other writers have accepted this record as valid, but no additional specimens have ever been collected. Since the species is otherwise almost exclusively Central American its occurrence in Trinidad must be considered very doubtful. Barbour (1930a, p. 112) erroneously considered Mole and Urich's citation of this record to have referred to *A. aeneus* Gray; the actual specimen preserved in the British Museum is certainly not Gray's species and is closely allied to, if not conspecific with true *biporcatus*.

(2) Leiocephalus herminieri (Dum. & Bibr.).

This species was described by Duméril and Bibron* under the name *Holotropis herminieri* from specimens said to have been collected by Plée and l'Herminier in Martinique and Trinidad. Although subsequent writers have continued to regard the species as a native of one or other of these two islands, no specimens have since been collected on either, and Barbour (1930, p. 97) has expressed the view that *L. herminieri* may have been based on specimens from Hispaniola. The reputed localities of many of the specimens collected by l'Herminier are open to doubt and it is significant, perhaps, that the next species, also said to have been collected by him in Trinidad has not been found there since. A consignment of specimens, collected on different islands, appears to have been sent to Paris from Trinidad, and the whole collection ascribed to the port of shipment.

(3) Ameiva major Dum. & Bibr.

This record, like the preceding, is based on a specimen collected by l'Herminier; the species has not been re-discovered on the island and there is considerable doubt whether it ever occurred there.

A further complication is added by the various guises under which different authors have recorded the species. Duméril and Bibron† first described the species from Cayenne and Trinidad under the name *Ameiva major* and the same name was used by Court (1858, p. 440). But Boulenger (1885, II, p. 359), considering *A. major* to be a synonym of *A. punctata* Gray, recorded the latter from Trinidad and in this he was followed by Mole and Urich (1894, p. 82). Finally, in 1887, Boulenger* placed *A. punctata* (including *A. major*) in the synonymy of *A. erythrocephala* Daudin.

Thanks to the courtesy of M. Angel the author has been privileged to examine the original "Trinidad" specimen of *A. major* and it seems certain that Boulenger was wrong in his synonymising, for the specimen is quite unlike either the type of *punctata* or specimens of *erythrocephala* from St. Eustatius, the type locality of Daudin's species. Strangely enough it does not agree with any species or sub-species represented in the British Museum, but its most characteristic feature, 16 to 18 longitudinal rows of ventral scales, suggests affinity with the form found on Guadeloupe and described by Barbour and Noble (1915, p. 453) as *Ameiva cineracea*. This is the only *Ameiva* known to have more than 14 rows of ventral plates and it seems quite possible that the original "Trinidad" specimen of *A. major* was really collected on Guadeloupe, or on one of the small neighbouring islands, such as Marie Galante or Martinique, where lizards of this genus probably existed in former days but are now almost or quite extinct.

(4) Cnemidophorus murinus (Laurenti).

Boulenger (1885, II, p. 361) gives the distribution of this species as "Guianas, Trinidad", but mentions no specimens from the latter; other authors have included the species in the lacertilian fauna of Trinidad on this statement. The record is apparently based on a manuscript entry in the British Museum catalogue of the receipt of two half-grown examples from Trinidad from a Mr. Cooper. This entry was made between the years 1845 and 1866 but the specimens themselves appear to have been lost before 1885 and no further details concerning them can be found. The species has not subsequently been found in Trinidad and Burt, in his recent monograph of the genus (1931), neglects Boulenger's record.

* *Erpet. Gén.*, IV, 1837, p. 261.
† *Erpet. Gén.*, V, 1839, p. 117.
* *Zool. Rec.*, XXIV, Rept., p. 11.

B. KEY FOR THE IDENTIFICATION OF THE SPECIES.

(1) (*a*) Limbs well developed .. .. (2)
(*b*) Limbs rudimentary or absent .. (17)

(2) (*a*) Geckoes; small, soft-skinned lizards without moveable eyelids .. .. (3)
(*b*) Larger lizards with moveable eyelids (8)

(3) (*a*) Hands and feet webbed; the digits widely dilated from base to tip (fig. 1). Pupil a vertical slit **Thecadactylus rapicaudus**
(*b*) Hands and feet not webbed; expansions, if present, confined either to the bases or the tips of the digits .. (4)

(4) (*a*) Digits widely dilated at the base (fig. 2). Pupil a vertical slit **Hemidactylus mabuya.**
(*b*) Digital dilations small or absent .. (5) Pupil circular.

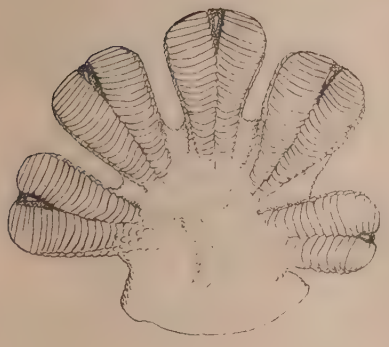
(5) (*a*) A small, asymmetrical expansion at the tip of each digit into which the claw is withdrawn laterally (fig. 3); a strong spine above each eye **Sphaerodactylus molei.**

(*b*) Digits very feebly dilated at the base; spines above the eye very short or absent .. .. (6)

(6) (*a*) Lamellae beneath the basal portion of each digit as wide as the digit itself (fig. 4); a very narrow vertical white line and sometimes a circular black spot in front of each shoulder **Gonatodes humeralis.**

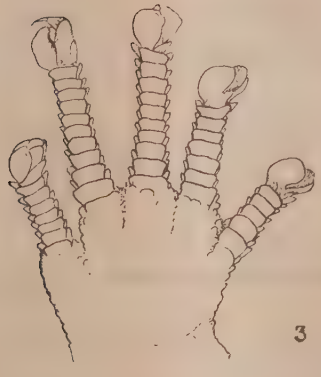
(*b*) Lamellae beneath the basal portions of the digits much narrower than the digits themselves (fig. 5) .. .. (7)

LIZARDS OF TRINIDAD

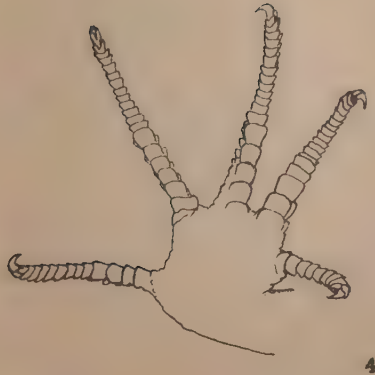


1.

2



3



4

5

(7) (*a*) Nineteen to twenty-two lamellae beneath the fourth toe. Males with a broad white, black bordered stripe from the tip of the snout along the back **Gonatodes vittatus.**

(*b*) Twenty-five to twenty-eight lamellae beneath the fourth toe. Males with the head mottled with brown and white, a broad blue, sepia-bordered bar in front of the arm and similar bars or ocellar spots on the flanks **Gonatodes ocellatus.**

(8) (*a*) Tongue flat, slightly nicked at the tip. Scales of the belly not arranged in regular transverse rows, usually not very different from those of the back .. .. (9)

(*b*) Tongue deeply bifid, snake-like. Scales of the belly much enlarged, sharply marked off from those of the back and arranged in regular transverse rows (Teiidae) (14)

(9) (*a*) Scales of the back small and granular; throat with a fan (gular sac) or with plicate folds across it (Iguanidae).. (10)

(*b*) Scales of the back large, and overlapping; throat smooth like the belly (Scincidae) **Mabuya mabouya aenea.**

(10) (*a*) Basal portions of the digits dilated to form adhesive pads .. .. (11)

(*b*) Digits not at all dilated .. .. (12)

(11) (*a*) Ventral scales smooth; a large golden-yellow gular sac (dewlap) **Anolis aeneus.**

(*b*) Ventral scales strongly keeled; a small, red-tipped, gular sac **Anolis chrysolepis.**

(12) (*a*) Body depressed; sides of the neck plicate and with tufts of small spines about the ear; no femoral pores **Plica plica.**

(*b*) Body compressed; no plicae or spines on the sides of the neck; a long row of femoral pores present .. .. (13)

(13) (*a*) Large green lizards with a strong, denticulate crest along the back and a large, non-dilatable dewlap **Iguana iguana.**

(*b*) Smaller lizards without any crest on the back and with only a small, dilatable dewlap **Polychrus marmoratus.**

(14) (*a*) Scales of belly strongly keeled; a black area (often broken up towards the tail) on each side of the back with a light longitudinal line through the middle of it **Kentropyx striatus.**

(*b*) Scales of belly quite smooth .... (15)

(15) (*a*) Large black lizards with yellow flecks and spots; belly yellow, with large black spots; tail with alternate black and yellow cross-bars **Tupinambis nigropunctatus.**

(*b*) Smaller lizards with the centre of belly uniformly coloured; tail not cross-banded .... (16)

(16) (*a*) Back with six or eight parallel, longitudinal light lines separated by black or dark brown **Cnemidophorus lemniscatus lemniscatus.**

(*b*) Centre of back olive or brownish, uniform or with some blackish spots and reticulations; juveniles with a broad, black, white-spotted lateral stripe; adults with the flanks beset with rows of circular, white or blue, black-edged spots and with the chin and throat black **Ameiva ameiva atrigularis.**

(17) (*a*) Tiny lizards with short limbs and functional eyes **Scolecosaurus trinitatis.**

(*b*) Worm-like lizards without limbs and with rudimentary eyes covered by the skin of the head .... (18)

(18) (*a*) Large, uniform white or flesh colour **Amphisbaena alba.**

(*b*) Smaller, heavily blotched and flecked with black **Amphisbaena fuliginosa.**

C. ANNOTATED LIST AND REFERENCES.

GECKONIDAE.

(1) Thecadactylus rapicaudus (Houtt.).

Gekko rapicauda Houttuyn, 1782, *Verh. Gen. Vlissigen*, IX, p. 323.
Platydactylus theconyx Court, 1858, p. 440.
Thecadactylus rapicauda Garman, 1887, p. 17.

(2) Hemidactylus mabouia (de Jonnès).

Gecko mabouia Moreau de Jonnès, 1818, *Bull. Soc. Philom. Paris*, p. 138.
Hemidactylus mabouia Court, 1858, p. 440.
H. mabuia Boettger, 1893, p. 28.

(3) Sphaerodactylus molei Boettger.

S. molei Boettger, 1894, in Mole and Urich, p. 80.
Sphaerodactylus buergeri Werner, 1900, *Verh. Zool.-bot. Ges.* p. 263; Barbour, 1921, p. 248.,
S. molei Barbour, 1921, Pl. I, fig. 4, Pl. XIII, figs. 5-8.

(4) Gonatodes humeralis (Guichenot).

Gymnodactylus humeralis Guichenot, 1855, in Castelnau, *Voy. Amér. Mér., Rept.*, p. 6.
Gonatodes humeralis Roux, 1926, p. 295.

(5) Gonatodes vittatus (Licht.).

Gymnodactylus vittatus Lichtenstein, 1856, *Nomencl. Mus. Zool. Berol.*, p. 6.

Gonatodes gilli Cope, 1864, p. 102.
Gonatodes vittatus Garman, 1887, p. 17.

Like all other species of the genus, this one shows a marked sexual dichromatism. Males have a vivid white, black-bordered stripe from the tip of the snout onto the tail and the belly is blackish. Females, on the other hand, are almost "pepper and salt" colour above and have the merest indications of a dorsal stripe; they are immaculate white beneath. It seems probable that males also undergo a seasonal change of colour. Sometimes the chin and throat are uniform white but in other examples there is a bold pattern of black and white. This consists of a central white Y or V, heavily outlined in black, and parallel with the edges of it are a series of white blotches all strongly outlined in the same way. No observations appear to have been made to ascertain when this character is developed and when lost; specimens collected on Mt. St. Benedict by Mr. Vesey FitzGerald in April have it well marked.

(6) Gonatodes ocellatus (Gray).

Cyrtodactylus ocellatus Gray, 1831, in Griffith, *Cuvier's Animal Kingdom*, p. 51.

? *Gonatodes ferrugineus* Cope, 1864, p. 79.

Gonatodes ocellatus Boettger, 1893, p. 24.

One of the first species of *Gonatodes* to be recorded from Trinidad was *G. ferrugineus* described by Cope from a single specimen which has subsequently been lost. The species has not been re-discovered and there is some doubt as to its status. The type, to judge from the fact that it was said to be cinnamon coloured, without distinctive markings, was probably a female and it seems quite possible that it may have been a female of the species previously described from Tobago as *G. ocellatus*.

The ventral colour of males shows a great deal of variation, possibly seasonal in its incidence. Only three Trinidad specimens with dates of capture are available to the author, all taken on Mt. St. Benedict. One, captured early in April (c.f. *G. vittatus*) has the throat beset with sub-circular white spots arranged in a dark brown reticulum and a dark brown belly; a second specimen, captured six weeks later has the same colouration, but less well marked, whilst the third example captured six weeks later still (July 14th) has the belly almost white and only the merest traces of a gular reticulum.

IGUANIDAE.

(7) Anolis aeneus Gray.

Anolis aeneus Gray, 1840, *Ann. Mag. Nat. Hist.*, V, p. 114.

Anolius alligator (*non* Dum. & Bibr.) Court, 1858, p. 440.

Anolis alligator Boulenger, 1885, II, p. 21.

Anolis trinitatis Reinhardt and Lütken, 1863, p. 269.

(8) Anolis chrysolepis Dum. & Bibr.

Anolis chrysolepis Duméril and Bibron, 1837, *Erpet. Gén.*, IV, p. 94; Mole and Urich, 1894, II, p. 81.

(9) Plica plica (Linn.).

Lacerta plica Linnaeus, 1758, *Syst. Naturae*, Ed. 10, p. 697.

Hypsibatus agamoides Court, 1858, p. 440.

Uraniscodon plica Boulenger, 1885, II, p. 180.

Plica plica Burt and Burt, 1930, p. 19.

Uraniscodon plica Ditmars, 1933, *Rept. World*, Pl. VIII.

(10) Iguana iguana (Linn.).

Lacerta iguana Linnaeus, 1758, *Syst. Naturae*, Ed. 10, p. 206.

Iguana tuberculata Court, 1858, p. 440.

Iguana iguana Burt and Burt, 1930, p. 10. Ditmars, 1933, *Rept. World*, Pl. XII.

(11) Polychrus marmoratus (Linn.).

Lacerta marmorata Linnaeus, 1758, *Syst. Naturae*, Ed. 10, p. 208.

Polychrus marmoratus Court, 1858, p. 440; Boettger, 1893, p. 60; Mole and Urich, 1894, p. 81.

TEIIDAE.

(12) Kentropyx striatus (Daudin).

Lacerta striata Daudin, 1802, *Hist. Nat. Rept.*, III, p. 247.

Centropyx striatus Boettger, 1893, p. 73; Mole and Urich, 1894, p. 81.

Kentropyx intermedius Barbour, 1930b, p. 100.

This lizard appears to be very rare in Trinidad and there has been some doubt as to its specific status. Boettger, in recording it from the island for the first time stated that the specimen was coloured like *K. intermedius* Gray, a remark which may have suggested to Barbour (1930b, p. 100) that its identification as *K. striatus* was wrong. But thanks to the courtesy of Dr. Mertens the original specimen, collected by Mole and Urich and reported upon by Boettger, has been re-examined; it is an undoubted *K. striatus*.

(13) Tupinambis nigropunctatus Spix.

Tupinambis nigropunctatus Spix, 1825, *Spec. Nov. Lacert Bras.*, p. 18.

Salvator merianae Court, 1858, p. 440.

Tupinambis nigropunctatus Garman, 1887, p. 1; Mole and Urich, 1894, p. 81; Ditmars, 1933, *Rept. World*, Pl. XIX.

(14) Cnemidophorus lemniscatus lemniscatus (Linn.).

Lacerta lemniscata Linnaeus, 1758, *Syst. Naturae*, Ed. 10, p. 209.

Cnemidophorus lemniscatus Boulenger, 1885, II, p. 363; Mole & Urich, 1894, p. 82.

Cnemidophorus lemniscatus lemniscatus Burt., 1931, p. 30.

(15) Ameiva ameiva atrigularis Garman.

Ameiva atrigularis Garman, 1887, *Bull. Essex Inst.*, XIX, p. 2; Barbour & Noble, 1915, p. 460.

Ameiva vulgaris Court, 1858, p. 440.

Ameiva surinamensis Boettger, 1893, p. 74; Mole & Urich, 1894, p. 81; Roux, 1926, p. 292.

Ameiva ameiva Barbour, 1916, p. 440.

(16) Scolecosaurus trinitatis Barbour.

Scolecosaurus trinitatis Barbour, 1914, *Mem. Mus. Comp. Zool. Harvard*, XLIV, p. 316.

Scolecosaurus cuvieri Boettger, 1893, p. 76; Mole & Urich, 1894, p. 82; Ditmars, 1933, *Rept. World*, Pl. XX.

AMPHISBAENIDAE.

(17) Amphisbaena alba Linn.

Amphisbaena alba Linnaeus, 1758, *Syst. Nat.*, Ed. X, p. 229; Court, 1858, p. 441; Mole & Urich, 1894, p. 82.

(18) Amphisbaena fuliginosa Linn.

Amphisbaena fuliginosa Linnaeus, 1758, *Syst. Nat.*, Ed. X, p. 229; Court, 1858, p. 440; Boettger, 1893, p. 77; Mole and Urich, 1894, p. 82.

SCINCIDAE.

(19) Mabuya mabouya aenea (Gray).

Lacertus mabouya de Lacépède, 1788, *Quad. Orip.*, I, *Syn. Meth.*

Tiliqua aenea Gray, 1831, in Griffith's *Cuviers' Animal Kingdom*, IX, *Syn.*, p. 70.

Eumeces spixii Court, 1858, p. 441.

Mabuya aenea Garman, 1887, p. 53; Barbour, 1930, p. 105.

M. agilis Boettger, 1893, p. 99; Mole & Urich, 1894, p. 82.

M. aurata Mole and Urich, 1894, p. 82; Roux, 1926, p. 292.

Burt and Burt (1933, p. 86) have recently shown that the two forms hitherto known as *M. aurata* and *M. agilis*, both of which have been recorded from Trinidad, are really conspecific. They use the name *M. agilis* Raddi (1823) for the combination, but it seems probable that de Lacépède's name *mabouya*, dating from 1788, is more correct.

The skink of Trinidad is one of a group of forms found through the Antilles (though now extinct on some islands) and in northern South America. These island races are regarded by some authors as distinct species, but others would accord them sub-specific status only, regarding the whole group as a single species. *Lacertus mabouya* of de Lacépède, described as inhabiting the Antilles and South America, is the oldest name available for this wider concept of the species, and *aenea* Gray is the sub-specific name applicable to the race inhabiting St. Vincent, Grenada, Trinidad and Tobago.

Barbour, 1914.—"A Contribution to the Zoögeography of the West Indies, with Especial Reference to Amphibians and Reptiles" *Mem. Mus. Comp. Zool. Harvard*, XLIV, 2, pp. 209-346.

Barbour, 1916.—"Amphibians and Reptiles of the West Indies." *Zool. Jahrb.*, Supp., XI, pp. 437-442.

Barbour, 1921.—"*Sphaerodactylus*." *Mem. Mus. Comp. Zool. Harvard*, XLVII, 3, pp. 217-278.

Barbour, 1930 (a).—"The Anoles. I. The Forms known to occur on the Neotropical Island." *Bull. Mus. Comp. Zool. Harvard*, LXX, 3, pp. 105-144.

Barbour, 1930 (b).—"A List of Antillean Reptiles and Amphibians." *Zoologica*, XI, 4, pp. 61-116.

Barbour and Noble, 1915.—"A Revision of the Lizards of the Genus *Ameiva*." *Bull. Mus. Comp. Zool., Harvard*, LIX, 6, pp. 417-479.

Boettger, 1893.—"Katalog der Reptilien-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft."

Boulenger, 1885-1887.—"Catalogue of Lizards in the British Museum (Natural History)." Vols. I-III.

Burt and Burt, 1930.—"The South American Lizards in the Collection of the United States National Museum." *Proc. U. S. Nat. Mus.*, LXXVIII, 6, pp. 1-52.

Burt and Burt, 1931.—"South American Lizards in the Collection of the American Museum of Natural History." *Bull. Amer. Mus. Nat. Hist.*, LXI, 7, pp. 227-395.

Burt and Burt, 1933.—"A Preliminary Check List of the Lizards of South America." *Trans Acad. Sci. St. Louis*, XXVIII, pp. 1-104.

Burt, 1931.—"A Study of the Teiid Lizards of the Genus *Cnemidophorus* with Special Reference to their Phylogenetic Relationships." *Bull. U. S. Nat. Mus.*, CLIV, pp. 1-286.

Cope, 1864.—"Descriptions of new American Squamata, in the Museum of the Smithsonian Institution, Washington." *Proc. Acad. Philadelphia*, 1863, pp. 100-106.

Court, 1858, in de Verteuil, *Trinidad*, Ed. 1.

Garman, 1887.—"On the West Indian Teiidae in the Museum of Comparative Zoology." *Bull. Essex. Inst.*, XIX, pp. 1-12.
"On West Indian Geckonidae and Anguidae".
"On West Indian Reptiles, Iguanidae".
"On West Indian Reptiles, Scinicidae".
Bull. Essex. Inst., XIX, pp. 17-53.

Mole and Urich, 1894.—"A Preliminary List of the Reptiles and Batrachians of the Island of Trinidad." *Journ. Trinidad Field Nat. Club*, II, pp. 77-90.

Reinhardt and Lutken, 1863.—"Bidrag til det vestindiske Öriges og navnligen til de dansk-vestindiske Öers Herpetologie." *Vid. Meddelelser*, 1862, pp. 153-291.

Roux, 1926.—"Notes d'erpétologie sud-americaine. I. Sur une collection de Reptiles et d'Amphibiens de l'île de la Trinite." *Rev. Suisse Zool.*, XXXIII, 4, pp. 291-297.

Werner, 1900.—"Ueber Reptilien und Batrachier aus Columbien und Trinidad." *Verh. Zool. bot.-Ges. Wien*, pp. 262-272.

FORESTRY IN BRITISH HONDURAS.

The chief note of the annual report of the Forest Trust of British Honduras for the biennial period ending March 31, 1933 (Govt. Printer ; 1934) is one of marking time. The Department has now had ten years experience, but the increasing depression in the trade of the Colony necessitated economy during the period under review and the personnel was reduced to a skeleton service. The Forest Trust had early decided that further sylvicultural work, with its long lock-up of capital, was to be discontinued, and all reserves were placed on a 'care-and-maintenance' basis, an expression which will convey little to the forester possessing an acquaintance with the tropical forest. The energies of the Department are to be applied, therefore, to the furtherance of research work into the exploitation and marketing of the secondary timbers, with the view of taking prompt advantage of the recovery of world trade, when the present depression lifts. So far as it goes, this may be regarded as satisfactory ; but the Department will have a long row to hoe before the position of half a decade or so ago is re-attained. The following extract from the report in connexion with *taungya* is of importance and should interest West African forest officers : "The practice of seeding-up the annual corn-plantation with mahogany continues to give excellent results. Mahogany seed is dibbled in lines with the maize at ten by ten feet intervals, and the area is abandoned after the first crop has been harvested. The mahogany is then sufficiently established to compete with the weed growth, which very quickly closes the canopy. Over-topping of the mahogany by weed-growth is found to be beneficial in preventing shoot-borer (*Hypsiphylla grandella*) attack. Tending consists of removing vines. It is becoming very apparent that huamil (secondary growth) conditions are very favourable to the growth of mahogany, which grows well whilst its head is just under huamil canopy, and that heavy cleaning is not only undesirable but often disadvantageous in rendering the mahogany susceptible to the shoot-borer attack." —(*Nature*, Vol. CXXXV, No. 3401, 1935, p. 27.)

THE SAND-FLY PEST (*Culicoides*).

By J. G. Myers.
Biological Control Research Officer.

Introduction.—For several months about the middle of 1934 sand-flies were unusually abundant and troublesome in the northern part of Trinidad, especially at St. Augustine. Silk-stockings were no bar to their biting at evening parties, while the ordinary mosquito-net, of course, allowed their ready entry.

The term sand-fly, as applied to this pest, is strictly speaking incorrect, since it belongs rightly to the small moth-midges of the genus *Phlebotomus* which are the carriers of sand-fly fever and other diseases. The small biting midges of the genus *Culicoides*, which are the subject of these notes, are not known to carry any disease*, at least in the New World, though an African species has lately been proved to transmit a filarial infection of man (*Filaria perstans*, not connected with elephantiasis). The Culicoides midges are known in the United States as "punkies" and in Spanish American countries as "jejénes". The term "sand-fly" is still further confused by its common misapplication in New Zealand to the black flies or buffalo gnats of the quite unrelated genus *Simulium*—the famous "piúm" or "kaboura fly" of South America. True *Phlebotomus* midges occur in Trinidad but are less widespread than *Culicoides*, and seldom or never in sufficient numbers to constitute a plague.

Having registered this protest in the interests of clear nomenclature, we shall continue in this article the probably unalterable West Indian usage and refer to the *Culicoides* midges and their relatives as sand-flies.

No special investigation has ever been made of Trinidad sand-flies; but two species have been recorded from the island by Dr. W. A. Hoffmann, based on material from Professor F. W. Urich, to whose assiduous collecting so much of our present knowledge of the Trinidad fauna is due. These two sand-flies are *Culicoides furens* and *C. trinidadensis*, the latter described by Hoffman as a new species. *Culicoides furens* was originally described in 1851 by the father of Cuban zoology, Felipe Poey, from the beaches of northern Cuba, where it is still a terrible plague. It occurs also in the Bahamas and has been found in Jamaica, Porto Rico, St. Vincent and Jamaica, so that its distribution probably takes in all the West Indies, while on the mainland it extends from Florida to Brazil. I have determined this species in Trinidad from the Eastern Main Road between Port-of-Spain and St. Joseph—that is, within no great distance from the mangroves of the Caroni River and swamp, where it probably breeds. In this vicinity it is in some years, as in 1934, a most troublesome pest. In the Bahamas it seriously detracted from the amenities of the bathing beaches and the winter tourist resorts that it was made the subject of a special investigation (Myers, 1932) with a view to control.

The second Trinidad species—and doubtless many more remain to be identified—is *Culicoides trinidadensis*, originally found by Mr. Urich on the Caroni River. This appears to be the one responsible for most of the annoyance in St. Joseph and St. Augustine in 1934. Its breeding places are not known.

The life-history of sand-flies.—The following account is based on studies of *Culicoides furens*, since *C. trinidadensis* has not been investigated.

The eggs are deposited in moist soil. Those of *C. furens* are still unknown, but the eggs of a West African species are described as sausage-shaped, and rather less than a third of a millimetre long. The larvae which hatch from these eggs and quickly bury themselves in the soil are active wriggling, slender eel-like creatures which eventually reach a length of 5.6 millimetres. They transform into much stouter pupae, not unlike that of a tiny mosquito, with two stout breathing horns projecting behind its head. From this emerges the adult sand-fly by a rent in the back. Emergence usually takes place in the evening probably about dusk, but in any case before 9 o'clock.

Patel found the duration of the various stages in an Indian species to vary as follows: egg, 3 to 11 days, larva, 2 to 10 weeks, pupa, 3 to 7 days —total 3 to 11 weeks. It is probable that the life-cycle of our species will fall within the same wide limits. I have kept adults (*C. furens*) of unknown age in captivity for eight days—it can probably live two weeks in the field. In the West African form studied by Sharp, at least one and probably two blood-meals are essential before the female can lay fertile eggs. One blood-meal is almost certainly necessary for *C. furens*, but it must be emphasized that the insect is by no means dependent on man for this. Sand-flies will attack almost any other vertebrates (*e.g.*, birds, dogs, &c.) at least as far down the scale as lizards.

The habits of sand-flies.—Only the females bite, and they are most annoying at certain hours, notably about sunrise and sunset. The limiting factor during the day, when they scarcely ever bite save in comparatively dense shade, is apparently chiefly light. During the middle hours of the night their activities are probably restricted by the decrease in temperature, though this does

* Since the above was written I have seen a notice of the discovery by Buckley (*Review of Appl. Entom.* Vol. 22, Ser. B., p. 251, December, 1934), that in St. Vincent, our Common West Indian sand-fly, *Culicoides furens*, transmits infection of the parasite, *Filaria ozzardi* to man. In Calliaqua some 38 per cent. of the inhabitants examined were infested.

not explain their prevalence at dawn. For full activity *Culicoides furens* apparently needs about 80°F. A much more important inhibitory factor than either strong light or low temperature is wind. During windy weather sand-flies remain well-hidden away and do not emerge to bite. This is of fundamental importance, since it means that sand-flies are not usually blown to points relatively distant from their breeding-grounds, as are mosquitos.

During unfavourable weather sand-flies take refuge in bushes in sheltered situations, and among the algae growing on old mangrove roots in the recesses of the swamps. In the Bahamas a favourite hiding-place is mosquito-screening of doors and windows on the lee side of buildings. In Honduras Bequaert most frequently found them in the leaf-sheaths of coconut palms.

The ideal night for sand-fly attack is sultry and still, with a temperature of 80° or higher, preferably after recent rains. Under such conditions *C. furens* will bite fiercely throughout the night and artificial light seems undoubtedly to attract rather than to deter them. Countless thousands are killed by near approach to hot electric light bulbs.

The question how far from its breeding-ground a sand-fly infestation makes itself felt can at present be answered only by circumstantial evidence, which, however, is varied and fairly convincing. Painter, in Honduras, found them biting on a diving platform, offshore 2,500 feet, from the nearest known or probable breeding-place. I found no infestation in the Bahamas which was not well within half a mile of a favourable breeding-ground.

The breeding-places of sand-flies.—In the Bahamas and probably elsewhere the ideal breeding-places for *Culicoides furens* are areas of waterlogged sand mixed with humus, not subject to actual flooding by any except unusually high tides, and more or less covered with a growth of mangroves. But even in such localities the sand-flies by no means breed evenly over the whole extent. A typical sand fly swamp or "swash", as it is called in the Bahamas, may be described as follows from a New Providence example: the sandy, or in places rocky, beach is backed closely by a sea-dune, often of considerable width and clothed with sea-oats (*Uniola*), coco-plum (*Chrysobalanus Icaco*) and low scrub. At some distance inland is a line of rock outcrops. Between these two ridges lies the swamp, into which extend the branches of a narrow arm of the sea, a creek in the original sense of the word. The margin of the swamp is everywhere clearly defined by distinct zones of vegetation. The lower portion, about the arms of the creek, is covered almost uniformly with common stilt mangroves (*Rhizophora mangle*). The upper portions and the margins are clothed with almost pure stands of low black mangrove (*Avicennia nitida*). While the muddy sand between the *Rhizophora* bushes is invariably bare, that among the *Avicennia* shrubs is often covered, though not densely, with the low reddish herbaceous plant, *Salicornia perennis*. On the extreme edge of the swamp, at the foot of the sea-dune and of the landward rock outcrop, is a thin line of other vegetation, chiefly white mangrove (*Laguncularia racemosa*) and button-wood (*Conocarpus erecta*) with denser beds of *Salicornia* and of the much greener sampire (*Philoxerus vermicularis*). Occasional patches of the salt-marsh grass, *Sporobolus virginicus* also occur here. The distribution of these different vegetation zones depends upon distance from tidal influence. In the upper part of the swamp are frequent and extensive patches of bare soil. The soil of the whole area is permanently waterlogged, while that in the immediate vicinity of the creek is flooded by every tide. The proportion of humus in the sand decreases as one approaches the mouth of the creek, where the sand is pure and almost white.

In the swamp thus briefly characterised, sand-flies (*C. furens*) breed in greatest abundance about the meeting-place of the common mangrove (*Rhizophora*) and the black mangrove (*Avicennia*) patches, and to a greater extent in the shade of the former than of the latter. They breed also, right up to the edge of the swamp, in the shade of white mangroves (*Laguncularia*), of sampire (*Philoxerus*) and of the grass, *Sporobolus virginicus*.

I was able to find none in precisely similar soil in the shade of *Salicornia*, nor in the bare patches. Neither does the sand-fly breed in the lower part of the common mangrove zone, where every tide covers the surface with several inches of water. To sum up, we may state that for breeding in numbers sand-flies (*Culicoides furens*) require (*a*) sand with a proportion of humus, permanently waterlogged with salt or brackish water, but not flooded, and (*b*) shade. It would be presumptuous to assert that odd sand-flies do not breed where some or even all of these conditions are lacking, but we are concerned here with main sources of infestation. The breeding-places of *Culicoides trinidadensis* are at present unknown; but from its abundance far from the sea it may reasonably be supposed less dependent on salt marsh conditions.

Whether the shade requirement depends upon light or temperature is not known. The sand-fly larvae, when disturbed, are most active in hiding from the light, and it may well be, since they are confined to the upper inch or two of soil, that the sunlight is too much for them in the open spaces. It is also likely that exposed soil, especially when a higher proportion of humus gives it a dark colour, reaches temperatures which are fatal to insect larvae. A series of observations in the Bahamas (New Providence) swamp described above, of soil temperatures in the upper inch, taking pairs of samples of the same colour and texture, one in the shade and the other in the sun, showed temperatures 14°F. lower under black mangrove bushes and 13°F. under common mangrove, than in the sun.

Fundamental control measures.—There can be no question whatever that the only sound method of tackling the sand-fly pest is to eliminate the

breeding grounds. This can be done effectively by either filling in or dredging out the swamps, but the practicability of this depends, of course, on the size of the swamps and the importance of the financial interests affected by the pest. If draining be decided upon—and several of the Bahamas swamps would lend themselves to this treatment—it is essential to keep the banks of the channels clean-cut and free from vegetation.

The value of wholesale oiling is even more problematical than in the control of mosquitos, since the distribution of sand-fly breeding-spots is, as we have, seen, very patchy. Frequent applications would be necessary, and would almost certainly affect the amenities of the bathing beaches where sand-fly control, at least in the Bahamas, is most often demanded.

Should dredging or filling-in of swamps prove impracticable on account of cost, then the complete clearing of vegetation (save perhaps *Salicornia*) from the surface of the soil is recommended. Experiments are desirable to ascertain how many cuttings are required to kill mangroves, especially the common and the black kinds, which are the most important. Herbaceous plants in most cases would prove a nuisance only on the edges.

So far as Trinidad is concerned, the first essential in any local or general scheme of sand-fly control is a survey of breeding-places in the light of the above data, and a special search for those of *Culicoides trinidadensis*, the life history of which is unknown.

Palliative measures against sand-flies.—The ordinary mosquito net unfortunately allows the ready passage of sand-flies. The common belief that a net of closer texture, slung well above the bed or hammock, excludes so much air-current, as to cause discomfort, is largely a superstition. I have slept in the greatest comfort under a cheese-cloth net, for months at a time on the South American mainland, under conditions of moist tropical heat never experienced in the islands. Such a net, provided it is well tucked-in, will not let a single sand-fly pass, and is undoubtedly the best protection against this plague.

Houses may be screened with wire-gauze, of not fewer than 40 meshes to the inch, but this special gauze is expensive, and the fittings of doors and windows usually in any case give entrance to a considerable number of sand-flies. Almost complete protection, even on " bad " nights, may be secured where the house is already screened against mosquitos by spraying the screens with kerosene in which has been steeped pyrethrum powder at the rate of a quarter of a pound in three pints.

The best known chemical deterrent of sand-fly attack is oil of pennyroyal. Bathers who are accustomed to use coconut oil as a protection against sunburn may employ instead, a mixture with equal parts of oil of pennyroyal. In my own experiments, during a heavy infestation, I found that the treated limb remained in comfort for two hours, while the state of the other was almost intolerable. If a chemical deterrent is preferred to a net, the bed and surroundings should be copiously sprayed with Flit or with naphthaline dissolved in kerosene, while the face and arms are anointed with coconut oil and pennyroyal as above. Under these conditions one can sleep at least four hours before an attack indicates that the spray or the oil needs replenishing.

Papers cited*.

Hoffmann, W. A., 1925.—A review of the species of *Culicoides* of North and Central America and the West Indies.—(*American Jl. Hygiene*, Vol. V, pp. 274-301, 1 text-fig., pls. I-II.

Myers, J. G., n.d. [? 1932].—Report on the sand-fly (*Culicoides*) investigation in the Bahamas.—Bahamas Govt. Publication, 18 pp.

Painter, R. H., 1926.—The biology, immature stages and control of the sand-flies (biting Ceratopogoninae) at Puerto Castilla, Honduras.—*United Fruit Co., Medical Dept.*, 15th *Ann. Rept.*, pp. 245-262, illus.

Patel, P. G., 1921.—Note on the life-history of *Culicoides oxystoma*, with some remarks on the early stages of *Ceratopogon*. *Rept. Proc. 4th Ent. Meeting*, Pusa, India, pp. 272-278, pl. 47.

* *See* fuller list in Myers, 1932.

COLOURING OF CITRUS FRUIT.

A graduate of the University of California at Berkeley has invented a dye for the colouring of citrus fruits which is creating attention among people interested in improving the commercial value of oranges shipped to the eastern markets of the United States.

Some sections in California seem to be handicapped by producing fruit of uneven colouration; this fact necessitates some improvement along the line of producing fruit of satisfactory colour which will be favourably received on the market.

A packing house near Santa Anna, California, is undertaking this dyeing process for the improvement of the colour of the fruit.

The fruit, after being washed and thoroughly disinfected, is conveyed into a large tank containing a hot solution of a reddish orange dye. It is kept in this solution for a short interval, and is later dried, waxed, sized and ready to pack. It is interesting to note that the colour attributed to the orange is firm and very satisfactory.

According to the inventor of the dye, the coloured fruit is favourably received on the American markets. An objection to this dyeing process is that the stem-end of the fruit is also coloured which gives the fruit a distinctly artificial appearance. This dyeing process is patented and the rights sold to the California Citrus Machinery Co. of Riverside, California.—(*Hadar*, Vol. VII, No. 10/11, 1934, pp. 252-253.)

REVIEWS.

CATTLE IN THE TROPICS.

By R. Cecil Wood, Prof. of Agriculture, Imperial College of Tropical Agriculture, Trinidad, pp. 41+ 4 plates and 7 figs.*

This account of tropical cattle husbandry is written primarily for those coming from temperate climates who may require to obtain a general knowledge of the subject and its problems. It forms an excellent introduction to the subject, being written by one who has had a long experience in many different tropical countries. It often happens that one or other of the cattle problems has been dealt with more satisfactorily in one area than in others, and the diffusion of this knowledge from one country to another by such a medium as this book can only be to the benefit of all concerned. This work begins the task of building up a written account of the principles of cattle husbandry in the tropics, for this at present is far behind that of the temperate zones. For the latter good textbooks exist but, since the conditions are so different, these are of little value for tropical conditions. To cite one instance only, the use of cattle for draught purposes is a subject which finds little or no place in the textbook of animal husbandry, but which is ably discussed and illustrated here. Few perhaps realise that as a source of power the working ox is responsible for the tillage of a larger area than any other draught animal.

After a short account of the species concerned and the environmental conditions which they have to encounter, the type of animal which has been evolved as a result is described in detail—the short hair, pigmented skin, and general conformation with drooping rump which is characteristic of *Bos indicus* and *Bos bubalus*. In the next section the utilization of cattle is dealt with and the management of draught cattle, and the methods of yoking as practised in different countries is described. The peculiarities of *Bos indicus* and *Bos bubalus* as compared with *Bos taurus* with regard to feeding are indicated; research has shown (and the references given to the literature should prove most useful to those who want further details) that, although the Zebu cannot make use of such large rations as cattle can, it has the faculty of obtaining nourishment out of most unpromising and low quality materials. The contrast in the methods of feeding in different countries, more particularly with regard to the uses made of grazing, roughages, or concentrated feeds, and the differences in the composition of these as compared with those of temperate climates, touches an important subject on which there is yet much more work to be done. Beef production is dismissed shortly, as being at present more of a by-product than a primary product of the tropics. The problems of milk production are discussed, and the account given of the primitive systems still adopted makes one realize what advances have been made in the temperate zones during the last century, and sets one thinking as to how the tropical milk supply might be improved if all the scientific advances made could be brought to bear on the problems. The solution of two of these—methods of making the cow let down her milk without the calf, and the difficulties of keeping liquid milk owing to the high temperatures—would alter the whole outlook for milk production in many tropical countries. Clean milking and refrigeration are being introduced in advanced areas, but even so the price of such milk is still above the level at which the masses of the population can afford to but it. Possibly in the future the use of pasteurisation may reduce the cost as it has done in Great Britain. The present difficulty of utilizing fresh milk (which in turn reacts unfavourably on the development of dairy cattle) is in part got over by the production of curds, but unfortunately in most cases (such as in the production of ghee instead of butter) the valuable proteins are lost. This side of the question touches an important financial problem for all tropical countries to-day, for with the present day policies of national self-sufficiency and the cutting down of international trade there is consequently a depression in price of exportable products. The building up within a country of an industry such as this which will give employment and raise the level of nutrition of the population therefore appears to offer great possibilities in building up the efficiency of labor, so that when the tide of international trade returns it can be taken advantage of.

The second part of the book deals with this side of the problem—the improvement of cattle and their by-products in the tropics. Many interesting suggestions are made concerning the improvements to be effected in nutrition, for example, fencing and rotational grazing in paddocks as a remedy for the over grazing which occurs when the natural nomadic habits of the natives are stopped by "civilization". The finding and selection of good strains of grasses for grazing purposes is required. The food supply question too is linked with that of quality versus quantity in live stock, which is a very important problem both in India and Africa, and needs solution in one way or another. Methods for the preservation of fodder and the use of mineral feeding are also dealt with. It is pointed out that this improvement of nutritional conditions should take place concurrently with, or slightly ahead of, a policy of improvement by breeding.

Improvements to be effected in general health are then considered, for the good work done by the Veterinary Research Institutes is fundamental to the establishment of a live stock industry in the tropics as elsewhere; among other things,

* Copies (price 2s.) obtainable from the author, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

dipping for the control of ticks, the methods of attacking the tsetse fly, and the preparation of serums for the control of various diseases are required in order to obtain the security necessary for the production of a better class of animal. In the third section improvements in breeding are discussed. The preliminaries for this, such as the prevention of indiscriminate breeding by the enclosure of land and by the castration of all but selected males (such as took place about 1750 in Great Britain) are now in progress in many tropical countries. Opposition to castration has been partially overcome by use of the Burdizzo method, but it is still very strong among those who require the heavy shoulders of the male for work purposes; this difficulty could probably be surmounted by the modern method of vasectomy which ensures sterility but allows development of all the male characters. As regards the methods of improved breeding there is a discussion on the two schools of thought. The first, which is centred mainly in India, puts its faith in the careful selection and breeding of native stock, and good results have been obtained with Sanhiwal cattle for milk production. The necessity for a continuous policy in the herd and for the permanency of the man in charge is duly stressed (in Great Britain it is considered that the building up of a good breeding herd of cattle is a life-time's work for a man), and changes in directors are not conducive to progress in breeding matters, especially as regards constitution. The second method, that of importing good cattle from other regions and building up a new breed by crossing and combining the production qualities of these with the constitution and resistance of disease of native cattle, has been successful with beef cattle in the southern parts of the United States and with dairy cattle in Hawaii and elsewhere. The successes and failures of this system in various tropical countries are discussed; the differing proportions of *taurus* and *indicus* blood necessary in each locality to give the optimum result would seem to afford an explanation for the varying results which have been obtained. The conflict of opinion which is now taking place as to which of these two methods is the better is discussed and references to much of the literature is given but, as the author rightly points out, whatever policy is adopted, little will be effected unless the policy is well defined and above all permanent.

Considering what the improvement of cattle has done for temperate zones in raising the standard of life, there could be no greater achievement in the tropics than the raising of the level of their cattle in a similar way. It is not without reason that the cow is considered a sacred animal in India, for the cow is the mother of mankind; progress however has now to be made in tropical cattle in productive qualities, and not in numbers as was formerly the case, for disease is now being held in check by veterinary research.

A short section on by-products sets out the advances which are being made. Since the export value of tropical cattle at present consists largely of their hides, the improvement of the methods of flaying and drying hides is a matter in which immediate returns can be obtained; for example, it is estimated that a good shade-dried hide is worth a shilling more than one which has been sun-dried. Finally a section on the organisation of the work of live stock improvement deals with the administrative action required in the way of research and education and the adjustments necessary between the Agricultural and Veterinary services.

It is a book which can be recommended to all those who are concerned with the future agricultural welfare of tropical countries.

JOHN HAMMOND.

* * *

Nixon, Roy W. THE DAIREE DATE. A Promising Mesopotamian Variety for Testing in the Southwest. *Circular No.* 300, U.S.A. Dept. Agric., Washington, D.C., July, 1934 $0.05, 12 pp., 5 Figs.

This is the first detailed description published of the Dayri (Dairee) variety, perhaps the fourth commonest variety in Basrah, first introduced into California in 1913, but only identified there recently by Mr. Nixon. In addition to an exact description of the palm and its fruit, the author discusses the value of the date under California conditions. He states that, although in Basrah this variety is not greatly esteemed owing to its dryness, it produces excellent moist dates in California, which are less susceptible than most to that damage by rain, which is the chief cause of loss to Californian date growers. Dayri dates perhaps owe this relative immunity, or some of it, to their original dryness.

V. H. W. D.

A NEW HEN.

Few successes of greater interest and practical possibilities have been won in the field of agricultural biology than the making of the new Cambridge hen. Her chicks declare their sex at birth, because the males and females are differently marked. This is a great advantage to the poultry industry, since chicks travel safely and well only during the first two days of their life. The new breed, known as Cambar, was developed by Dr. R. C. Punnet and his associates at Cambridge, England, by the application of Mendelian principles. By the use of the Canadian Barred Plymouth Rock (supplied by the University of British Columbia to Cambridge University), both silver and golden Cambars have been evolved. They are prolific layers of large, coloured eggs, whilst still possessing the virtue of sex-linked chicks. These breeds mark an epoch in the scientific breeding of poultry.—(*The Spectator.*)

CHEMICAL COMPOSITION OF GRASSES AND LEGUMES.

The awakened interest shown within recent years in the possible value of leaf analysis for diagnosing plant nutrient deficiencies in the soil, for formulating manurial practices for specific crops growing on particular types of soil, and for improving the balance of manurial mixtures, renders any authoritative publications on this subject of considerable moment. A recent contribution is a paper by H. A. Daniel of the Oklahoma Department of Agronomy, which appeared in the June 1934 number of the *Journal of the American Society of Agronomy*, pp. 496-503, and entitled "Calcium, Phosphorus and Nitrogen Content of Grasses and Legumes, and the Relation of these Elements in the Plant".

Although a large mass of data has been published on the chemical composition of forage crops, only a few calculations of correlations between the different elements present have been made. The results issued by Dr. Daniel, attempt to lessen this deficiency. Composite samples (368 in number) of mature grasses (23 different species) were collected during 1929 to 1933, from virgin lands within 52 counties of Oklahama. Legume samples (335 in number; 10 species) from experimental plots, were likewise investigated. The dried material was chemically analysed for calcium, phosphorus and nitrogen. The main results obtained, and comparisons of nutrient ratios, may be summarised as follows:

Grasses.—Considerable variation in chemical composition was demonstrated for different samples of the same species of grass due to differences in soil fertility, and great variation was found for different species of grasses. The average contents for all the samples analysed were, calcium, 0.351 per cent.; phosphorus, 0.103 per cent.; and nitrogen, 0.868 per cent. The ratio for nitrogen to phosphorus is high; for calcium to phosphorus, and for nitrogen to calcium, low. Only a small degree of correlation exists between calcium and phosphorus, so that grasses containing small amounts of calcium may often contain relatively large amounts of phosphorus. The same is the case for calcium and nitrogen, but phosphorus and nitrogen contents are closely positively correlated.

Legumes.—The average composition of the leguminous species analysed was, calcium, 1.373 per cent.; phosphorus, 0.180 per cent.; and nitrogen, 2.283 per cent. Hence leguminous plants contain nearly four times as much calcium, one-and-three-quarters as much phosphorus, and over two-and-a-half times as much nitrogen as grasses. Legumes show high nitrogen-phosphorus ratio, and low nitrogen-calcium ratio, just as the grasses, but the ratio of calcium to phosphorus is high, the reverse of the grasses. A negative correlation exists between calcium and phosphorus in legumes, so that, when calcium is abundant in them, phosphorus is usually lacking. As in grasses, nitrogen and phosphorus are closely positively correlated.

In general, both sorts of plants when they contained low amounts of calcium and phosphorus, showed no greater amounts of these two elements when grown in more fertile soil, and crops containing high calcium and phosphate contents showed little difference in this respect when grown in poor soil. Analytical results (approximated) for a few selected species are reproduced below for purposes of reference.

	Average Percentage Composition.			Nutrient Ratios.		
	Ca.	P.	N.	Ca : P.	N : Ca.	N : P.
(A) Grasses.						
Andropogon sorghum, Sorghum ..	0.33	0.09	1.23	3.7	3.7	13.6
Cynodon dactylon, Devil's Grass ..	0.66	0.18	1.29	3.7	2.0	7.3
Sporobolus asper, Seed Grass ..	0.20	0.10	0.58	2.0	2.9	6.0
Bouteloua gracilis, Grama Grass ..	0.31	0.11	0.93	3.1	3.0	9.3
Panicum virgatum, Switch Grass ..	0.29	0.11	0.93	2.6	3.2	8.5
Paspalum dilatatum, Dallis Grass	0.19	0.14	1.11	1.3	5.9	8.1
(B) Legumes.						
Arachis hypogaea, Groundnut ..	1.89	0.06	1.27	29.1	0.7	19.6
Vigna sinensis, Cowpea ..	1.83	0.16	1.94	11.1	1.1	11.8
Soya max, Soya bean	1.08	0.18	1.80	6.1	1.7	10.0
Stizolobium sp. Velvet Bean ..	1.67	0.16	2.43	10.4	1.5	15.2
Phaseolus aureus Mung Bean ..	1.52	0.12	1.27	12.7	0.8	10.6

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

World Production of Oils and Fats.

M. Emile Baillaud, the general secretary of the Institut Coloniale de Marseilles, has recently published in the *Bulletin des Matieres Grasses* some interesting statistical information on the world situation of oils and fats. Important points from his review are as follows :—

The consumption of arachis oil during 1933 was greater than that in 1932 but less than that of 1931. The total production of the last harvest is higher.

A very considerable decrease in imports by consuming countries is noted in the case of palm kernels. This is due to the decreasing importance of the industry, particularly in England. Palm oil, on the other hand, showed an increase in consumption by all the principal countries.

The coco palm as opposed to the oil palm was not faced with a decreased consumption in 1933. This was due to the development of a demand for copra and copra oil in the Far East. This increase corresponds to the increase in the number of palms in production and is particularly noticeable in the Philippines.

With regard to the soya bean, an interesting development is its increasingly important domestic cultivation in the United States. In the first place, soya was cultivated solely as a stock feed, but attention is now being concentrated on varieties which are rich in oil and protein and researches have been carried out which demonstrate the possibility of producing varieties having a high nutritive value for both human and animal food.

An examination of M. Baillaud's important work shows the immense difficulty of attempting the delicate task of drawing definite conclusions from the world's statistics for fats and oils.

Considering only the immediate situation we see the possibilities of production of all classes of material becoming greater than the needs of the consumers, the only exception being the case of linseed oil. On the other hand, the effects of restrictive legislation must not be forgotten. But at the same time we must not forget that if the temperate countries of the world restrict their use of the oils produced in the tropics, uses will be found for these oils in other countries.—(*Food*, November 1934, p. 71.)

* * *

Fuel from Peat Tar.

The scientific workers of the Leningrad Industrial Institute have obtained a liquid fuel of high quality from peat tar. Benzine, ligroin, kerosene, phenols, pitch, and fuel for Diesel and steam engines, have all been prepared from it. These products may also be applied in the rubber, leather and plastic industries. Construction of an experimental plant for producing liquid fuel from peat will be started at the end of 1934.—(*Ind. and Eng. Chem. News Ed.*, Vol. XII, No. 22, p. 413, 1934.)

Silver, an Effective Bactericide.

A new and interesting commercial application of metallic silver in sterilizing water has been brought much to the fore. Silver and some other metals when their surface is exposed to clear water, show the "oligodynamic effect", that is a small quantity passes into solution. In the process as practised, the passage of silver-ions into solution is facilitated by passing the water between thin flat silver electrodes through which a low direct current is passed, the direction of which is reversed every few minutes. After the treatment, the water is allowed to stand for a short period and then becomes sterile. It can be diluted with further water, and continues to act as a sterilizer so long as there is sufficient concentration of free silver, which is of the order of one in 20 millions for drinking water. The positive silver-ions no doubt act by combining with the negatively-charged bacteria, or, expressed in organic chemical phraseology, the silver combines with the exposed SH groups of the proteins in the bacteria and disrupt these proteins. The applications of silver in this way, both for sterilizing drinking water, large swimming baths, and other fluids, are already considerable, and its use has certain obvious advantages. The quantity of silver which might be taken into the body from water so sterilized is of no importance compared with the quantity which is ordinarily consumed in the shape of rubbings from spoons and forks. The water has to be clear before treatment, since, if it is turbid, the particles act as nuclei to adsorb the silver-ions.

Apparently the sterilizing action of silver can be applied widely throughout the food industries and extended to wines and to vinegar, which when silverized instead of pasteurized, are said to run no danger of being reinfected. These low concentrations seem also to have a catalytic effect in ageing and stabilizing certain liquids and extracts. It would seem that there is a new chemistry awaiting silver, and it may happily play the proverbial part of a silver lining to water in both its liquid and cloud state.—(*Chemistry and Industry*, 30th November, 1934, Editorial, p. 1011.)

* * *

Lanolin Rust Preventers.*

The investigations described cover a five-year period, and the present issue presents fuller information than was available when the report originally appeared. According to the data, the most satisfactory and economical method of preserving the bright steel parts of stores machinery from rust is to coat the metal with partially refined lanolin. The mixtures recommended are 7.8 lb. of lanolin dissolved in one gallon

* Engineering Research Special Report No. 12, Department of Scientific and Industrial Research, London, 2nd edition, H.M.S.O., Adastral House, Kingsway, London, W.C. 2. Price 6*d*.

of white spirit, or 8.3 lb. of lanolin in one gallon of solvent naphtha. This quantity applied with a soft brush will cover approximately 1,200 square feet of surface.

The recommendations are based on the results of tests made, not only in the laboratory, but at sea on vessels passing through the tropics, and also in stores. Even in a badly corroding atmosphere, as in an ammonium nitrate shed, satisfactory protection is reported for a period of three years.—(*Ind. and Eng. Chem. News Edition*, Vol. XII, No. 22, p. 419, 1934.)

* * *

Pectin from Beet Pulp in the Soviet Union of Russia.

The pulp from which sugar has been extracted by diffusion is heated in an autoclave for 15 minutes at 115° C, and then filtered. The liquified product contains about 3 per cent. of pectin, and about one-half of the solid matter of the pulp becomes soluble. The solution is filtered and then concentrated *in vacuo* to 50 per cent. pectin content. Formaldehyde is added to preserve the pectin syrup, which is stored or shipped in this form. The syrup may be dried to thin plates, similar in appearance to gelatin leaves.

Pectin in solution is used to replace glue, gum arabic or dextrin, and, for some industrial purposes, it is superior to animal glue. The demand for the substance is far in excess of the supply, the textile industry alone requiring large amounts annually, some 30,000 tons in Russia.

The main source of pectin so far has been citrus residues from the lemon, orange and grapefruit industries, where large numbers of culls are used for juice expression, the peel and fibre furnishing excellent sources of pectin.—(*South African Sugar Journal*, Vol. XVIII, No. 11, 1934, p. 697.)

NOTES ON BIOLOGICAL CONTROL OF INSECT PESTS IN THE BAHAMAS.

By W. T. Dalgarno, M.A., B.Sc., A.I.C.T.A.

In the Bahamas there is no Department of Agriculture or Director of Agriculture but a Board of Agriculture composed of five lay members who are appointed annually. It is difficult, therefore, to get continuity of attack on any agricultural problem over a period of years, as is necessary in work on biological control. This colony, however, has been fortunate in having the kind co-operation of the United States Department of Agriculture which is always ready to help with information, material, &c., while its assistance has played a large part in controlling several notorious pests in the Bahamas.

The first biological control experiment in the Bahamas was the introduction of the wasp *Eretmocerus serius*, which is a parasite of the Black Fly (*Aleurocanthus Woglumi*) known in the Bahamas as the Blue Grey Fly. Before the introduction of the parasite the Board of Agriculture had been spending several hundred pounds yearly in an effort to keep the citrus industry alive, no small a sum in the agricultural vote of a small colony. *Eretmocerus serius* was introduced from Cuba into the Bahamas in 1931 by Mr. Berry of the United States Department of Agriculture, working in conjunction with the Cuban authorities. It quickly established itself and by June, 1932 was distributed over the major part of New Providence. Since then little spraying against the Black Fly has been necessary and a considerable amount of money has been saved.

Encouraged by these results those in authority decided to try a similar experiment with the Mealy Bug (*Pseudococcus citri*). In July, 1932 500 lady-bird beetles (*Cryptolaemus Montrouzieri*) were introduced from Florida. Unfortunately these arrived in a very bad state. Fifty per cent. were dead and the survivors very weak. No success attended this effort but it is hoped to try it again in 1935.

The latest venture has been the introduction of the Vedalia lady-bird beetle (*Rodolia cardinalis*) as a predator against the Cottony Cushion Scale (*Icerya Purchasi*). The first introduction was made in October, 1933 and again in October of this year, 1934. For this introduction the colony is greatly indebted to Dr. Wolcott of the Puerto Rican Department of Agriculture and the co-operation of the United States Bureau of Entomology. Not only did Dr. Wolcott supply predators in large numbers but he also furnished concise information as to the best way of establishing them. It is too soon yet to say what the results will be but present indications are that the predators are spreading steadily although, perhaps, not so fast as was anticipated.

It is interesting to note the introduction of the Cottony Cushion Scale into the West Indies. In the Journal of the Department of Agriculture of Puerto Rico, July, 1933, Dr. Wolcott describes the position in that island where it is a recent introduction. The Cottony Cushion Scale was first seen in the Bahamas in 1929. Since then it has been spreading steadily on the island of New Providence. In this colony it has a large number of host plants including citrus, pigeon peas, logwood, mulberry, cherry, Casuarinas, roses and many ornamentals. This scale seems to be particularly partial to roses, and makes it a great menace in a colony where landscaping is a major vocation. The Cottony Cushion Scale has slipped across America from California to Florida and now it is getting a footing in the West Indies. Unless strict quarantine regulations are enforced it may creep down the West Indian Islands, where so far the author has not seen it recorded in any reports except from Puerto Rico.

The Editor requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Conductivity Control of Pan Boiling.—*D.G. Conklin.* At Kahuku Plantation in Hawaii experiments were made with a small coil seed pan with copper electrodes connected to a Leeds & Northrup ratio recording conductivity instrument. Two adjustable resistance boxes are used, one as a standard reference and one in the pan electrode circuit, so that any desired range can be had. Circulation of the massecuite is aided by direct injection of live steam. It is found that the best results are obtained by boiling at a very slight supersaturation during the first half of the boiling period, with a progressive concentration thereafter, but in this method care is required to avoid false grain. By means of the conductivity instrument the author compared the "waiting method" of producing grain with the so-called "shock seeding" method. In the latter method a charge of molasses of 60 purity is drawn into the pan and concentrated to the point where crystals are about to be formed; a small amount of powdered sugar is then sucked into the pan; concentration is continued for about six minutes, using steam for artificial circulation, until sufficient grain has been formed. The mass is then suddenly diluted with water to a point of very low supersaturation as shown by the conductivity instrument. This method cuts the time in half as compared with the waiting method and produces a more uniform grain. The author has successfully boiled strikes without reference to gauge glasses, proof stick or thermometer, using only the conductivity instrument. The pan man's "alibi" is therefore reduced to the vanishing point.—(*Facts About Sugar*, Vol. XXIX, No. 12, 1934, pp. 447.)

* * *

Determination of the polarization of very small quantities of Juice (for Ripeness Tests).—*K. Douwes Dekker and H. J. Monsanto.* Ripeness tests using the hand refractometer have suggested to the authors the desirability of working out a method by which one could determine the pol. of very small amounts of juice. Having the pol. and by also taking the refractometric Brix reading, one would obtain the purity figure, using the very small amount of juice extracted by the corer.

Using a Goerz laboratory refractometer, it is possible to read the index to 1 or 2 units in the fourth decimal place, and the temperature to 1 or 2°C., thus giving an accuracy of 0.1° Brix. The scale of the hand refractometer, as usually used in these tests, is divided into 0.2° Brix, but no correction is made for temperature. Seeing that 1°C. corresponds to nearly 0.1° Brix, it is hardly likely that a closer accuracy than 0.3° Brix can be reached. It is more likely to be rather higher than this, at least 0.4°.

In polarimetric readings, using the 200 mm. tube, one should be able to read to 0.1°V; but the problem before us is to approach this accuracy with the use of a much smaller volume of liquid than the ordinary polarimeter tube requires, which is about 12 cc. Say one were to use a 50 mm. tube (made by cutting a 100 mm. tube in half, and re-cemented the screwed end), this would require about 3 c.c. of juice, which is still rather much. Generally the internal diameter of the polarimeter tube is 9 mm. but this might be reduced by inserting a piece of tubing having a bore of only 3 mm. and grinding its edges level with the ends of the ordinary tube. Then the quantity of liquid actually required to fill the tube would be only 0.3 c.c., which would be obtained from the clarification of at most 2 c.c. of liquid.

Therefore, the procedure would be to place 2 c.c. samples of juice in small test-tubes (16 by 1 cm.) to add 30 mgrms. of dry basic lead acetate, to shake, to stand for a few minutes, to filter, to fill the 50 mm. tube with the filtrate (using a finely drawn out pipette for so doing), and lastly to polarize, placing the tube close to the lamp-end of the trough of the polarimeter. Having multiplied the polarimetric reading by 4, and having also read the refractometric Brix of the unclarified juice as accurately as possible (using the laboratory instrument), one can calculate the purity from *Erlee's* or other suitable tables.

That this method gives satisfactory figures appears from a table giving the results of 20 tests, the average quotient of purity using the 50 mm. tube being 92.43, and that using the 200 mm. tube being 92.34, an average percentage difference of 0.098 only. Precautions to be observed in this "micro-polarization" are that all the apparatus used must be clean and dry; and that during filtration the funnels be covered with watch-glasses. Samples brought from the field to the laboratory are preserved by the addition of one drop of one per cent. sublimate per 2 c.c. of juice in the test-tubes, in which case an allowance at the rate of one per cent. must be made for the diminished polarization and Brix readings thus caused.—(*Int. Sugar Jr.*, Vol. 36, No. 429 p. 362, 1934.)

* * *

Utilization of Waste Heat in the Boiler Room.—*S. Mott-Smith.* This paper is an exposition of the advantages of an economizer or "flue feedheater", which utilizes the waste heat in the flue gases to heat the feed water going to the boiler. As the author figures it, the gain in boiler room efficiency may be of the order of 6.35 per cent., but 9.25 per cent. more steam will be generated than formerly. An economizer may obviate the necessity of buying oil for supplementary fuel when the supply of bagasse is inadequate under existing conditions. These conclusions are based on experience at Kilauea plantation. The first cost of the economizer unit is relatively high, but the rate of depreciation should not exceed about four or five per cent. a year.—(*Facts About Sugar*, Vol. XXIX, No. 12, 1934, pp. 447).

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.)

	Foreign.	*Preferential.*
	s. d.	*s. d.*
27th December	4 3¾	8 0¾
3rd January	4 5¼	8 2¼
10th January	4 6	8 3¾
17th January	4 6	8 2¼
24th January	4 6	8 0
31st January	4 6	7 10½
7th February	4 6	8 0¾
14th February	4 2¼	7 11¼
(15*th Feb.*, 1934)	5 6¾	10 3¾

A quieter tone has prevailed for some time in the Market with values registering slight declines under the influence of the continued lack of buying power in the raw sugar section. The sharp appreciation of the dollar, owing to the U.S. Supreme Court proceedings in connexion with the legality of the abrogation of the Gold Clause by the U.S. Government prior to the devaluation of the dollar in 1933, has, according to *C. Czarnikow Ltd.*, caused a good deal of interest in commercial circles. Whatever the decision of the Supreme Court, however, it is felt that a way will be found to maintain the dollar at its present devalued level. It is stated that plantings this year in Java will be limited to an area yielding a maximum of 300,000 tons of sugar so that the final clearance of Java's burdensome surplus is now in sight.

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F.G.F. Sakel.*
4th January	7.23	8.98
11th January	7.18	9.01
18th January	7.15	9.09
25th January	7.07	8.88
1st February	7.08	9.00
8th February	7.04	—
15th February	7.03	—
(9*th Feb.*, 1934)	6.80	9.47

The tone of the market has been rather uncertain but there has not been any particular change in the level of prices. Business has been somewhat disturbed by uncertainty as to the decision relating to the "Gold Clause" case in the American Courts. World production according to the U.S.A. Department is estimated for this season at 23 million bales compared with 26,100,000 in the previous season. There has been more inquiry for West Indian Sea Island, but only a limited business has resulted. Sales of white cotton at from 13½*d.* to 15½*d.* and of stains at from 8*d.* to 8½*d.* are recorded.

RUBBER.—Quotations for Plantation Sheet have ranged as follows:—

	pence per lb.
27th December	6 3-8
2nd January....	6 1-4
9th January	6 11-16
16th January	6 7-16
23rd January	6 3-8
30th January	6 1-16
6th February....	6 1-8
13th February....	6 5-16
(14*th Feb.*, 1934)	4 29-32

Quotations have eased slightly consequent upon somewhat violent fluctuations in the American dollar exchange and lack of interest on the part of buyers. At the rubber conference held at the end of January in Batavia it was decided to continue, for the time being, the export duty system in the four large areas where no decision regarding restriction has yet been made. A census of producers and of trees is being taken and the possibility of introducing a scheme for the regulation of output has not been abandoned. Total consumption for 1934 in the U.S.A. worked out at 455,997 tons which very closely approaches that for the boom year 1929 when 469,905 tons were consumed. The preliminary estimate of world consumption for 1934 is given by Messrs. *Symington & Wilson* at 925,000 tons which represents an increase of 115,000 tons on that for 1933.

* * *

COCOA.—The cocoa market remains quiet but steady and future developments are looked forward to with interest pending the decision to be made in the American courts over the Gold Clause Case. The American market is slightly better despite heavy receipts. In the month of January 459,000 bags were received or 172,000 bags in excess of the same month last year. Out of this Accra contributed 255,000 bags against 103,000 less in 1934. Price quoted for this grade is 23*s.* to 24*s.* fair fermented and locally $6.70 to $6.80 per fanega is paid for Plantation.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

BANANAS.—The available supplies of Jamaicas have met a steady demand and the price to wholesalers is £1 per ton higher at £18 5*s.* delivered London and £18 nearest station Provinces. Brazilians continue to be quoted at £18 nearest station.—(*West India Committee Circular* 17th January, 1935.)

* * *

COFFEE.—At the last auctions about 40 barrels of Blue Mountain Jamaica were offered, bold selling at from 185*s.* to 209*s.* and 3rd size at 105*s.* The market generally is flat.—(*West India Committee Circular*, 17th January, 1935.)